ICES-FAO WORKING GROUP ON FISHING TECHNOLOGY AND FISH BEHAVIOUR (WGFTFB; outputs from 2024 meeting)

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Contents

i Executive summary

The Working Group on Fishing Technology and Fish Behaviour (WGFTFB) discusses and synthesizes recent research on topics related to fishing technology and fish behaviour in relation to commercial fishing and survey gears. The group provides guidance for management and industry, including, *inter alia*, gear selectivity, reducing the impacts of fishing on the environment, and innovative technologies for improving fishing and research operations. The working group is jointly supported by the International Council for the Exploration of the Sea (ICES) and the Food and Agriculture Organization of the United Nations (FAO), which have fostered a fruitful working relationship in an international forum. WGFTFB supports FAO members and other ICES working groups and workshops, facilitating the exchange of knowledge and promoting collaboration, and providing expertise upon request on fishing technology and fish behaviour.

The 2024 annual meeting of WGFTFB was hosted by the Fisheries and Marine Institute of Memorial University of Newfoundland in St. John's, Newfoundland and Labrador, Canada from 3-7 June. The 95 meeting participants convened daily in plenary to attend 15-minute scientific presentations (49 total) on the topics of: benthic interactions, energy use, selectivity, discard survival, representative talks from the Topic Groups (ALDFG, Multi-Use, and Indicators), human behaviour, fish behaviour, innovative gear, and innovative gear as it pertains to whale interactions. In addition to oral presentations, posters were displayed for the duration of the meeting, and on Monday (June 3) afternoon authors stood by their posters to answer questions from meeting participants. During the meeting, it was decided that the next two meetings will take place from 15-20 May 2025 in Mazara del Vallo, Sicily (Italy) and in Cairns, Queensland, Australia in May 2026 (dates to be determined at 2025 meeting in Sicily). In addition, the first in-person meeting of the ICES Working Group on Size and Species Selection Experiments (WGSSSE), chaired by H. Einarsson (Iceland) and M. Pol (USA), was convened on June 2nd to coincide with the annual WGFTFB meeting given overlap in participation.

ii Expert group information

Expert group name	ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB)
Expert group cycle	Multiannual fixed term
Year cycle started	2024
Reporting year in cycle	1/3
Chair(s)	Noëlle Yochum, USA
	Antonello Sala, Italy
	Jon Lansley, Italy
Meeting venue(s) and dates	3-7 June 2024, St. John’s, Newfoundland and Labrador, Canada (95 participants)

1 Explanatory Notes on Meeting and Report Structure

The meeting began with a reception the night before the official start of the event, where the meeting participants were welcomed by Paul Brett, Vice President at Memorial University, on behalf of Memorial University and by Sheilagh O'Leary, Deputy Mayor, on behalf of the City of St. John's. For the following week, the meeting convened daily in plenary with 15-minute scientific presentations. On Wednesday (June 5), the three Topic Groups met concurrently following a morning plenary session with representative presentations for each of the groups. The Topic Groups were:

(1) the use of indicators to describe and compare the performance of fishing ("Indicators"; year 2);
(2) abandoned, lost or otherwise discarded fishing gear ("ALDFG"; year 2); and
(3) operational and technical constraints of fishing gears to support coexistence with offshore wind and open-ocean aquaculture "(Multi-use"; year 1).

This was followed by the meeting banquet at The Launch, The Marine Institute's "living lab" facility. On Thursday (June 6) the first WGFTFB "Focus Session" was held in plenum: Sampling instruments and AI for fishing technology and fish behaviour research. The focus of the presentations given in this session was to summarize current and past work in relation to technological developments in sampling instruments used for obtaining fishing technology and fish behaviour (FTFB) observation and data, to discuss instruments and methods and their limitations that are used to collect these data on (commercial fishing) vessels, and to identify synergies, developments and make recommendations on how to improve technologies used in FTFB research.

During the lunch breaks, flume tank demonstrations were given by Notus Electronics (demonstrating trawl monitoring equipment; Monday), Hampidjan (giving a company overview; Wednesday), and Precision Seafood Harvesting (demonstrating the FlowMo System; Thursday). On Tuesday there was a tour of the Fisheries and Marine Institute's Centre for Sustainable Aquatic Resources; Centre for Aquaculture and Seafood Development; Centre for Marine Simulation; ROV Lab; and Diesel Engine Room. Following the tour, participants selected between either visiting Notus Electronics Ltd. our sightseeing at Signal Hill and Cape Spear. Both groups rejoined subsequently at Bannerman Brewery in St. John's.

The Business Session, held on Friday (June 7), included the selection of a new co-chair for 2025-27 to replace Antonello Sala (Italy) at the end of his term. Paul Winger from the Fisheries and Marine Institute of Memorial University of Newfoundland in St. John's, Newfoundland and Labrador, Canada was selected and will start his term in January 2025. In addition, the 2025 meeting and FAO hosted 2026 annual meeting were discussed, including presentations and updates about location and timing, and getting WGFTFB member feedback. The meetings will take place from 15-20 May 2025 in Mazara del Vallo, Sicily (Italy) and in Cairns, Queensland, Australia in May 2026 (dates to be determined at 2025 meeting in Sicily).

At the 2025 meeting, the ALDFG and Indicator Topic Groups will meet for their third and final year, and the Multi-use Topic Group will meet for its second year. Two potentially new topic groups were discussed during the business session but were not selected for 2025. These included a Topic Group on on-demand (ropeless) fishing gear and one on catch welfare in commercial fisheries. A Focus Session on "research failures, no effects and lessons learned" was also proposed and was selected for inclusion during the 2025 annual meeting. The aim of this focus session will be to create a platform that "highlights not our greatest successes, but our failures,

unexpected outcomes, and the lessons learned from them." A second focus session was added after the meeting: Collating and standardising the reporting of bottom-contacting, mobile fishing gear parameters and their fuel consumption. The aim of this focus session will be to collate a globally representative database on mobile, bottom-contacting fishing gears.

The business session also included a summary of the National Reports by Georg Haney (Iceland), which describe the research being conducted (and planned for) globally that relates to fishing technology and fish behaviour. Also included was an FAO update, a summary of the WGSSE meeting, an update on BeFish (the fish behaviour group that developed from WGFTFB members), and an update on the publication that came from the WGFTFB "Light" Topic Group. There was also an invited presentation by Silvana Dans to give an overview of redCID an Ibero-American network for the study of bycatch and discards, and a discussion about how WGFTFB can increase collaboration and engagement with this group.

The report of the 2024 annual meeting of the WGFTFB includes detailed information about the presentations given in plenary (Chapter 3; Annex 4). Although discussion followed individual presentations, comments are not included in the text of this report. The contents of the individual abstracts were not discussed fully by the group, and as such, they do not necessarily reflect the views of the WGFTFB. Also included are the posters presented (Chapter 4; Annex 4), the three Topic Groups that met in parallel on the third day of the meeting (5 June; Chapters 5-7), and the Focus Session that was convened in plenum (Chapter 8). Also included are the National Reports (Chapter 9), which provide information about current and planned research activities related to fishing technology and fish behaviour. These were solicited, compiled, and summarized by a representative for each interested country. Other business is detailed in Chapter 10 with information about the upcoming annual meetings in 2025 and 2026, and information about a meeting of the ICES Working Group on Size and Species Selection Experiments (WGSSSE) that coincided with the 2024 WGFTFB annual meeting. WGSSE met in-person for the first time the Sunday preceding the WGFTFB annual meeting (2 June) in St. John's given the overlap in participants between the two working groups.

Appendices in this report include a list of participants (Annex 1); the 2024-26 resolution for WGFTB (Annex 2); the 2024 meeting agenda (Annex 3); a list of the presentations and posters (Annex 4); the opening address by FAO chair Jon Lansley (Annex 5); and a summary results from the opening interactive questionnaire given by the chairs (Annex 6). While audio/video of the plenary sessions was streamed through Facebook Live, information was not collected on who or how many observers attended the meeting in this way. For that reason, the participation list only includes in-person participants.

2 Opening of the meeting

Paul Winger, Director of the Centre for Sustainable Aquatic Resources, Fisheries and Marine Institute of Memorial University (CSAR) briefly welcomed meeting participants before handing the floor to Lucy Stoyles, Parliamentary Secretary to the Minister of Fisheries, Forestry, and Agriculture to deliver a welcome address on behalf of the Province. Lucy highlighted the importance of the fisheries sector to Newfoundland and shared her background and personal experience growing up within a fishing family.

The CSAR Director then delivered a Land Acknowledgement, acknowledging that the Memorial University campuses are situated in the traditional territories of indigenous groups before providing some background on the structure and history of the Marine Institute. The importance of the fisheries sector to Newfoundland was reiterated, in terms of both income and employment, and a description of the main fisheries and fishing zones was provided. House-keeping items and activities for the week were presented before handing the floor to the WGFTFB chairs for their welcome presentation.

ICES Chair Noëlle Yochum welcomed participants and introduced the other Co-Chairs Antonello Sala representing Italy, and Jon Lansley representing FAO.

The FAO Co-Chair reminded the WG that the main objective of this collaboration for FAO is to involve more developing countries in the work of this group so that they may learn and benefit from ICES members expertise and to facilitate development of sustainable fishing technologies and operations in developing countries. He further stressed the challenges of transferring skills & knowledge to the fisher communities of developing countries, and the need to achieve real benefits contributing to hunger reduction and reduced poverty. This was recognised as a huge challenge that the WG can contribute towards, and ideas were welcomed.

The ICES Co-Chair provided an overview of the ICES/FAO WGFTFB website, reminding of available re-sources and encouraged use of the online blog to exchange information and share photos, and posting of peer reviewed publications to avoid circulation of papers by email.

An outline of the logistics for the meeting, a recap on the 2024-2026 ToRs andWG objectives and a reminder of the importance of adhering to the ICES code of ethics, professional conduct and core values such as embracing diversity was provided by the ICES Chair. This was followed by a recap on the standards for good scientific practice, the need for reporting misconduct and being aware of any potential conflicts of interest. The agenda for the week was then introduced and some final instructions and reminders for moderators and presenters to ensure a smooth delivery of the meeting.

Information on the flume tanks, an invitation for participants to explore the institute, facilities and meet the staff, and details on the field trips and banquet to be held later in the week was provided by the CSAR Director.

Details on the focus sessions and topic groups were provided by ICES Chair who invited participants to select which group to follow, gave an overview of what to expect within the business session taking place on Friday and advised of the need to identity during the course of the week a replacement for the ICES Co-Chair whose term will expire at the end of 2024.

The session was then closed with a warm welcome to all participants and wishes for a productive week.

3 Presentations in plenum

In this section, the abstracts are listed in the order as presented during the meeting by the session topic (see Annex 3). These include benthic interactions, energy use, selectivity, discard survival, representative talks from the Topic Groups (ALDFG, Multi-Use, and Indicators), human behaviour, fish behaviour, innovative gear, and innovative gear with a focus on whales. The abstracts of posters are given in Chapter 4; and the presentations given during the Topic Groups and the Focus Session are listed thereunder (Chapter 4, 6, and 7; and Chapter 8, respectively). There were 49 presentations given in the plenary sessions.

3.1 Session 1: Benthic Interactions

(1) Enhancing our understanding of global variability in industrial fisheries footprints; a synthesis of mobile, bottom-contacting fishing gears

Mollie Rickwood[1], Christopher Kerry[1], Ole Eigaard[2], Ciaran McLaverty[1,2], Antonello Sala[3], Ruth Thurstan[1] & Kristian Metcalfe[1]

[1] *Centre for Ecology & Conservation, Faculty of Environment, Science and Economy, University of Exeter*

[2] *DTU Aqua, National Institute of Aquatic Resources, Technical University of Denmark*

[3] *Consiglio Nazionale delle Ricerche (CNR), Ancona (Italy)*

The Convex Seascape Survey is a five-year project which aims to better understand interactions between carbon and the seascape. To achieve this, a greater understanding of the influence of human activities on redistributing oceanic carbon is required. One of the greatest sources of carbon release within marine environments is thought to come from sediment disturbance as a result of bottom contacting fishing gears. However, currently global assessments rely on the extrapolation of vessel size â€“ gear relationships from the European fleet. In this talk, we will present findings from an extensive literature review that demonstrates how bottom-contacting gear sizes in the European fleet differ from other regions which may be leading to an overestimation of carbon release. We will call on the working group to help populate a survey that aims to collect more regionally representative gear size information in order to improve the accuracy of estimates.

(2) Sediment penetration by bottom contacting fishing gear components

Finbarr G. O'Neill[1], Morteza Eighani[1] & Esther Savina[1]

[1] *DTU Aqua*

The penetration of towed fishing gears into the seabed is directly related to their contact drag and fuel consumption, habitat alteration and to the depletion of benthic fauna. Here, we investigate the penetration of bottom contact gear components into soft sediment substrates by using a benthic sledge to tow cylindrical components over the seabed. We take high resolution measurements of the penetration depth of the components while the impact is taking place, with a stereo camera system that has sub-millimeter accuracy. We develop an empirical model which relates the penetration of these components to their weight, towing speed and to the type of sediment on which they are towed and demonstrate that penetration is greater both on softer sediments and with increased weight and decreases with faster towing speeds. We emphasize the need to extend these studies to all bottom contact components. The resulting models would lead to better

assessments of the impact of towed demersal fishing gears. Specifically, they would provide more accurate estimates of the Relative Benthic State of a fishery, which is an indicator that is central to the fisheries impact assessment methodology being developed by ICES WGFBIT. They would also help identify mitigation measures and contribute to the design of low impacting, fuel efficient gears of reduced drag.

(3) The snagging of towed demersal fishing gears on boulders

Nurul Huda, Ole Eigaard, Tiago Veiga-Malta & Finbarr O'Neill

National Institute of Aquatic Resources (DTU AQUA), Technical University of Denmark

The interaction of towed demersal fishing gears and seabed features and obstructions can have economic, safety, ecological and environmental consequences. The loss or damage of a snagged gear can result in missed fishing opportunities, and the financial cost of having to replace or repair the gear. Snagging gears on seabed obstructions can also have serious safety implications, and there have been incidences where vessels have sunk, and lives lost following a snagging event. Further, there are ecological and environmental concerns, and Abandoned, Lost or Discarded Fishing Gear (ALDFG) can continue to fish, and will degrade with time to produce microplastics. The physical interaction between fishing gears and seabed structures may damage, displace or remove underwater features which can lead to habitat destruction, benthic mortality and the degradation of seabed integrity.

In this study we investigate the interaction of towed fishing gears and seabed features. We carry out a flume tank study, using small scale models of an otter trawl, seine net ropes, and tickler chain and chain mat beam trawls and idealized boulders of different size and shape. Our aim is to (i) identify which gears are more likely to snag on boulders, (ii) evaluate at which part of a given gear snagging is more likely to occur, and (iii) determine if there are any characteristic features of a boulder that increases the likelihood of snagging. Our results indicate that it is the tickler chain beam trawl that is the most likely to snag or come fast and suggest that it is gear strength and vessel power that are the determining factors informing decisions on where fishing takes place rather than the likelihood of snagging.

(4) Impact of the mooring systems on seabed

Chiyo Takahashi[1], Saranya Raju[1], Yutaka Maruyama[1], Satoshi Masumi[1], Jun Uchida[1], Makoto Kabeyama[1], Alifro Maldini[1], Gregory N. Nishihara[1], Miyuki Hirose[1] & Yoshiki Matsushita[1]

[1] *Nagasaki University*

The objective of this study is to investigate the impact of mooring systems on the seabed. Two studies were conducted in waters in Nagasaki, western Japan. The first was to estimate the scoured area near the anchor rope of a fisheries training vessel (gross tonnage: 155 tons, total length: 42.79 m). The depths at seven points on the anchor rope were recorded by depths gauges during mooring at the recordings were conducted at seven locations from July to November 2021. The position of the vessel, current speed, current direction, wind speed and wind direction during mooring were recorded with instruments onboard the vessel. The position at which the anchor rope touched bottom was estimated from depth gauge data and was used to estimate the scoured area (i.e., the area of seafloor swept by the anchor rope). The scoured area had a maximum value of 11,031.9 mÂ² and a minimum of 0 m2. A GLM was used to analyze the data and we inferred that scoured area was related to wind speed.

The second study was done in an eelgrass (*Zostera marina*) bed from July to November 2023. We deployed a mooring system consisting of an anchor, chain, rope, and buoy in an eelgrass bed

(study area) and compared changes to eelgrass coverage and surrounding biota among the deployment area an area where no mooring equipment were placed (control area). Coverage of eelgrass decreased from the margins of the eelgrass beds in both areas. In addition, eelgrass coverage declined in the interior of the eelgrass bed of the study area, suggesting that the mooring system causes a negative impact. No clear relationship was found between the decrease in eelgrass coverage and changes in the surrounding biota for this short-term observation (less than a year) and longer observations are necessary in any future study.

3.2 Session 2: Energy Use

(5) Assessment of artificial light on the headline towards improving energy efficiency in the Celtic Sea trawl fishery for demersal fish species

Martin Oliver[1], Matthew McHugh[1], Daragh Browne[1], Shane Murphy[2], Cóilín Minto[2] & Ronán Cosgrove[1]

[1] *Bord Eastaugh Mhara*

[2] *Atlantic Technological University*

We assessed the use of artificial lights on the headline of a mixed demersal trawl targeting haddock and hake in the Celtic Sea. BIM previously assessed lights on raised-fishing line (RFL) trawl gear. Results showed a significant reduction in low-quota cod but also some reductions in targeted haddock, hake and whiting with fish likely moving away and dipping under lights mounted on the fishing line to escape. Potential negative effects on commercial viability made it difficult to recommend use of lights on the RFL at that time but the study did raise some interesting questions around potential energy efficiency applications. This trial aimed to take advantage of this negative phototaxis to try and improve catch rates of target species and operational efficiency.

The trial was conducted on board a 23.4 m trawler targeting mixed demersal fish species in the Irish sector of ICES Division 7j in the Celtic Sea in March 2023. The vessel fished a single rig otter trawl with 18 mm leaded footrope attached to the fishing line. The vessel deployed a 100 mm diamond (T0) mesh codend and 160 mm square mesh panel. Alternate hauls were conducted with lights on and lights off. 14 Lindgren-Pitman® green (LPG) light emitting diodes were attached to the headline of the trawl with ~ 150 cm spacing between each light.

Trial results were positive. Haddock was the dominant species corresponding to 90% by weight of all commercial species landed with 60% of haddock catches occurring at night-time. Observed haddock catches were 51% greater with lights on the headline during night and 9% lower with lights on the headline during daytime. Size dependency, variable diurnal effects and economics of the effects of lights on haddock are discussed.

(6) Development of an innovative and light-weight chain mat for the Belgian beam trawl fishing fleet

Mattias Van Opstal[1] & Jasper Van Vlasselaer[1]

[1] *Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences – Fisheries*

Impacts of chain mats on the marine environment form a major challenge in Belgian beam trawl fisheries. In this project, a new chain mat design was developed that aimed to reduce the ecological impact of the fishing gear by reducing fuel consumption, limiting bottom impact, improving catch composition and improving survival. We developed a low tech and low-cost design to guarantee maximum accessibility for the sector.

Traditional chain mats in beam trawl fisheries serve a dual purpose of preventing debris from entering the codend and startle flatfish from the seabed. We replaced the conventional chain mat with a lighter variant solely dedicated to the prevention of debris entering the net, while introducing "tickers" ahead of the bobbin rope to startle flatfish from the seabed. Through fishing trials conducted on board of RV Belgica, we evaluated the performance of the innovative gear compared to traditional chain mat gear. Results indicated similar catch rates between the two gear types, but significant reductions in the catch of small sole (<26 cm) and small dogfish (<45 cm) were observed when using the innovative gear. Short-term (72 h) survival assessment of plaice showed no difference between the two gear types. Despite the current design leaving room for improvement, it already proves an accessible innovation for fishers operating in areas with limited sole quota. This study underlines the potential of low-tech innovations in mitigating the ecological footprint of beam trawl fisheries.

(7) Using pair seining to reduce fuel in a demersal fishery

Matthew McHugh[1], Martin Oliver[1], Daragh Browne[1], Rory Campbell[1], Ronan Cooney[2] & Ronan Cosgrove[1]

[1] *BIM*

[2] *BIM*

Irish fly shooters (seiners) typically operate individually with one net. Following on from a recent pair bottom trawling trial, BIM completed a trial on pair seining with the primary aim of assessing catches and energy efficiency. Two similar vessels were chartered to tow a single seine net using 660 m (60 mm Ø) combination wire rope near the net and 259 m (32 mm Ø) wire before a (1,000kg) clump weight and Dyneema warp. For a solo vessel comparison, the vessels involved supplied data on catches and operational information from subsequent trips. Operationally there was a greater (68%) swept area—7.6 versus 4.5 km2. While catches were similar between solo and pair operations, it was possible to fish effectively at night for the pair operation, whereas nighttime fishing is not commercially viable for solo operations. Fuel consumption and carbon emissions (kg CO2 eq/hr) were estimated to be 25% lower for each of the pair seiners compared to solo operation. Additionally, engine load was lower by up to 33% while pair seining. The results suggest that pair seining is a viable option for Irish seine-net fleet and with potential for improved profitability and energy efficiency once nighttime fishing is fully evaluated.

(8) Two birds with one stone: simultaneous improvements of fuel efficiency and catch performance in demersal trawling

Ludvig A. Krag[1], Valentina Melli[1], Finnbar G. O'Neill[1] & Junita D. Karlsen[1]

[1] *Technical University of Denmark, DTU Aqua*

In demersal trawl fisheries, advancements in gear technology have enhanced size or species selectivity. The integration of these developments into the technical legislation remains limited, with minimal uptake within the industry. Moreover, demersal fisheries are challenged by simultaneously evolving challenges, needing not only to reduce unintended bycatch but also preserve habitat and improve fuel efficiency. Consequently, there is a pressing need for fishing gear innovations that offer more comprehensive solutions.

This study addresses a suite of these challenges by aiming to i) minimize catches of unwanted bycatch and ii) simultaneously reduce drag during gear towing, thereby decreasing fuel consumption and associated CO2 emissions, while iii) avoiding conflicts with existing technical regulations. Moreover, the study endeavours to iv) devise a straightforward design alteration that

allows for easy conversion and reversion of existing demersal Nephrops (*Nephrops norvegicus*)-directed trawls.

Our findings demonstrate, in a catch comparison set-up, that constructing the top panel of a Nephrops-directed trawl with very large mesh significantly reduces the bycatch of roundfish without compromising the yield of Nephrops. Concurrently, the drag was diminished by 10% during gear towing. This research underscores the potential for simple, yet effective, gear modifications to mitigate environmental impacts and enhance sustainability in fisheries operations. The developed gear design does not conflict with the technical legislation and the first fishing vessels have on a voluntary basis been using the design in seasons and areas with high catches of unwanted roundfish.

3.3 Session 3: Selectivity

(9) INSER R Package: INdicators of SElectivity in Routine

Marie Morfin[1] & Sonia Méhault[1]

[1] *IFREMER, Fishing Gear Technology and Biology*

Reducing fishing discards is a major concern for fisheries resource managers. Modifying gear by increasing mesh sizes or inserting selective devices is one of the means used by fishermen to reduce catches of undersized individuals or unwanted species. Experiments are regularly carried out on board commercial vessels to quantify the effectiveness of the devices tested. This involves observing catches by collecting a series of indicators such as the size, number and weight of individuals and species caught. The R package developed as part of the INSER project is designed to apply several treatments and statistical tests to these indicators in order to produce a summary report of the performance of the devices tested onboard of trawlers. This work, still under progress, presents the approach and functions of the 'inser' tool, which is intended for the entire community of fisheries scientists who want a rapid and systematic analysis of selectivity data. The final output will allow to assess the effectiveness fishing gear modification which can be rapidly reported to managers and professional fishermen.

(10) Selectivity in snow crab (*Chionoecetes opilio*) pot fishery: effect of escape gap shape and size for conservation of fishery resources

Kristine Cerbule[1,2], Bent Herrmann[1,2,3], Jure Brčić[4], Eduardo Grimaldo[1] & Zita Bak-Jensen[3]

[1] *UiT The Arctic University of Norway*

[2] *Department of Fisheries Technology, SINTEF Ocean*

[3] *DTU Aqua, Technical University of Denmark*

[4] *University of Split, Department of Marine Studies*

Conical pots are commonly used fishing gear for capturing snow crab (*Chionoecetes opilio*). In these fisheries, optimal snow crab size selection is important for reducing unintended mortality of undersized individuals aiming at conserving fisheries resources and reducing sorting time onboard fishing vessels. Size selection in snow crab pot fisheries is commonly taking place through pot netting meshes during deployment. The diamond mesh netting has varying opening angles affecting retention of snow crab of different sizes, and often large proportions of catches consist of undersized crab challenging natural resource conservation. Therefore, in some snow crab fisheries escape gaps are considered to supplement mesh selection. We predicted the size selection potential of escape gaps with different shape and size and investigated whether such

additional size selection mechanism can have a potential to improve selectivity compared to mesh selection. Results showed that circular escape gaps have potential to provide sharper size selection compared to netting meshes and thus could be used to limit the capture of undersized snow crab which is relevant for management and conservation of snow crab resources. However, a similar positive effect cannot be obtained to the same extent with elliptical and rectangular escape gaps.

(11) King scallop selectivity in the English Channel dredge fishery

Daragh Browne[1], Shane Murphy[2], Matthew McHugh[1], Cóilín Minto[2], Martin Oliver[1] & Ronán Cosgrove[1]

[1] *Bord Iascaigh Mhara (BIM)*

[2] *Atlantic Technical University*

The western and eastern English Channel/ la Manche (ICES Divisions 7.e and 7.d) are important fishing areas for Irish dredge fishing vessels targeting king scallop (*Pecten maximus*). A number of EU technical measures are in place to protect scallop stocks in these areas such as: closed areas and minimum conservation reference sizes (MCRS). Newhaven-style dredges predominate in the fishery, with dredge backs comprising steel rings and washers. Irish scallop dredge fishers typically use a ring size diameter of 85 mm, whereas French fishers use 92 mm and 97 mm diameter rings. Irish scallop fishing representatives requested BIM carry out a trial to assess the effect of increased ring size on scallop catches using fishing gear and practices representative of the Irish fleet. A catch comparison trial was conducted in the western Channel (ICES Division 7.e) during November 2023 to assess the effect of increasing ring size on scallop catches. Dredges were fitted with 85, 92 and 97 mm ring sizes and deployed simultaneously. Scallop catches were weighed and measured. Proportional differences in catch at width were modelled using a generalised additive model (GAM). Compared with the 85 mm ring size: the 92 mm ring size significantly reduced scallop catches less than the MCRS (≥ 100 mm) and did not reduce scallop catches greater than the MCRS (100 mm); and the 97 mm ring size significantly reduced scallop catches less than and greater than the MCRS. Our experimental design attempted to account for differences in dredge fishing power related to position along a beam. It was not possible to change ring backs from one beam to another to assess differences in beam fishing power due to poor weather. The trial Skipper kept the 92 mm gear on board his vessel after the trial and reported some loss of greater than MCRS scallops as the rings were subject to wear. These caveats aside the findings of this trial are similar to those of a 2020 French study (SELEDRAG) conducted in the eastern Channel (ICES 7.d).

(12) Are we wasting tax-payers money? Questioning the use of sea trials to test simple codend modifications

Tiago Veiga-Malta[1], Ludvig Ahm Krag[1] & Jordan P. Feekings[1]

[1] *DTU Aqua*

A T90 120 mm codend, i.e. standard diamond mesh (T0) rotated by 90°, was proposed for the Danish demersal trawl fishery in the North Sea to address high catches of undersized roundfish, including haddock (*Melanogrammus aeglefinus*) and cod (*Gadus morhua*). This proposal was based on the legality of a similar codend in the Baltic Sea, suggesting its applicability to the North Sea. However, the Danish fisheries authorities recommended an experimental sea trial to specifically assess the T90's effectiveness in the North Sea compared to the legal codends in the area (e.g., 120 mm diamond mesh codend). A sea trial was then set to compared T90 and T0 codends using

a twin-rig trawl setting, sampling four commercial species: cod, haddock, plaice (*Pleuronectes platessa*), and lemon sole (*Microstomus kitt*). Results indicated an overall reduced catch efficiency with T90 meshes for fish below minimum landing size. For cod and haddock, a loss of catch efficiency was found for individuals below 43 and 40 cm, respectively, resulting in loss of some commercially sized individuals. For both flatfish, a moderate increase of catch efficiency for some length classes of the smaller commercial sizes was also found. These findings closely matched predictions based on Baltic Sea data, prompting reconsideration of the need for costly sea trials given the accuracy of predictive modelling in evaluating gear efficacy. Our findings advocate for reallocating resources towards refining predictive models for gear selectivity, while reserving sea trials for testing more intricate or untested gear modifications. In conclusion, while sea trials can validate theoretical models, our study suggests that in certain cases, such as assessing a simple gear modification like T90 codends in North Sea fisheries, modelling exercises may adequately replace extensive field testing, highlighting the importance of efficient resource allocation in fisheries research and management.

(13) Novel escape window reduces redfish bycatch in Northern shrimp trawls

Tomas Araya-Schmidt[1], Shannon M. Bayse[1], Paul D. Winger[1] & Sidney Andrade[1]

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The offshore Northern shrimp bottom trawl fishery in eastern Canada faces challenges associated with significant bycatch of juvenile redfish (*Sebastes* spp.) prompting the exploration of novel behavioural bycatch reduction devices (BRDs). This study assesses the effectiveness of an experimental escape window integrated into a traditional shrimp trawl with 22 mm bar spacing Nordmøre grids to reduce redfish bycatch while maintaining targeted Northern shrimp catches. Video recordings and catch comparison methods were employed during at-sea trials off the coast of Labrador in Eastern Canada. The experimental trawl caught significantly fewer redfish for all size classes and was more efficient at reducing smaller individuals as showed by the increasing slope of the modelled proportion retained and catch ratio. The catch ratio suggested that on average the escape window trawl caught 57.09% fewer redfish (CI: 47.72% - 64.39%). Qualitative video observations provided evidence of the active swimming behaviour of redfish through the escape window. While the escape window demonstrated promise, challenges remain as ~43% of redfish could not escape, suggesting the need for further modifications and testing. The research also highlighted the importance of considering additional modifications to the escape window to improve its efficiency as well as testing the escape window in combination with smaller bar spacing Nordmøre grids. Further studies could explore the combined benefits of these BRDs and assess their impact on overall bycatch reduction.

(14) Make fisheries better by reducing size selectivity

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In the Barents Sea demersal trawl fishery targeting cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*), it is mandatory to use a fish sorting grid with minimum

bar spacings of 55 mm. However, earlier studies have reported low catch efficiency for this gear, resulting in increased fishing effort to catch available quotas, higher fuel use and greenhouse gas emissions, and seabed disturbance as consequences. Further, it reduces the profitability of the fishery. Therefore, the effect on capture patterns and efficiency of lowering the grid bar spacings was investigated in a specific case study. Our results demonstrated that lowering the grid bar spacing by 10 mm improved the catch efficiency for cod, haddock and saithe by 51%, >100%, and >300%, respectively, when measured in number of fish. The fraction of undersized fish was low for all cases and did not exceed 2% for any species. When quantified by weight, a 10 mm reduction in grid bar spacing resulted in a 26%, 84%, and >200% improvement in catch for cod, haddock and saithe, respectively. The fraction of undersized fish did not exceed 1%. Furthermore, the results showed that the grid selection alone enables the use of a gentle, but potentially non-selective codend, because the fraction of undersized fish, when measured in number of fish, was less than 3% for cod and saithe and about 10% for haddock. Thus, our results indicate that environmental impacts, and the profitability of the fishery could be improved by allowing fishers to use sorting grids with smaller bar spacings. However, additional studies are needed to confirm that our results can be extrapolated to fisheries beyond our case study.

(15) Uppers and downers: picking a sustainable gear for a new redfish fishery

Shannon Bayse[1], Paul Winger[1], Zhaohai Cheng[1], Vang Nguyen[1], Gebremeskel Kebede[1], Harold DeLouche[1], David Kelly[2], Haraldur Einarsson[3], Michael Pol[4] & Stephen Walsh[5]

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The redfish (*Sebastes mentella* and *S. fasciatus*) trawl fishery in the Gulf of St. Lawrence, Canada has been in moratorium for the last 25 years. Massive recruitment events from 2011, 2012, and 2013 have led to a large biomass of slow-growing redfish soon to be targeted again by commercial fishing. Over the last five years, much research interest has been invested in developing a sustainable redfish trawl. Of many gears tested, a T90 mesh codend showed promise to reduce small-sized redfish. However, industry and management had concerns that reductions in the catch of small redfish were only realized at the surface, i.e. the majority of escapes happened when the trawl was at the surface, which would have led to mortality given redfish's biology. Thus, a second study investigated the timing of when redfish escaped from a T90 mesh codend to determine if it happened at fishing depth, haul back, or at the surface. Results showed that redfish have escape events periodically during trawling at fishing depth with a T90 mesh codend and relatively few fish were observed to escape during haul back or at the surface. Overall, results from two studies show promise for using a T90 mesh codend in the incipient Canadian redfish fishery.

(16) Understanding and predicting codend size selection for flatfish species

Zita Bak-Jensen[1], Bent Herrmann[1,2,3], Juan Santos[4], Daniel Stepputtis[4], Valentina Melli[1] & Jordan P. Feekings[1]

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In several demersal trawl fisheries flatfish constitute a large part of the catch, but often a significant fraction of these flatfish are unwanted species or sizes. A key knowledge when designing trawls to address this problem is to understand and quantify size selection of flatfish species by meshes in the codend. In the laboratory we tested the ability of different sizes of three flatfish species, plaice (*Pleuronectes platessa*), flounder (*Platichthys flesus*) and dab (*Limanda limanda*) to physically pass through different diamond meshes. By combining these results with results from fishing trials we were able to obtain a deeper understanding of how flatfish species are selected by size in trawl codends. Specifically, our results suggest that variation in the angle of the fish approach to the meshes when attempting to escape appears to play a major role in the size selection of flatfish species. Opposed to swimming power during mesh penetration that appears to have very limited effect. The results raise questions about if it is relevant to include more factors and which in the future selectivity and FISHSELECT studies.

(17) Evaluating bottom trawl fishery in the Bay of Biscay from the fish community perspective

Elsa Cuende[1], Mikel Basterretxea & Bent Herrmann

[1] *AZTI*

Typically, the capture performance in trawl fisheries is evaluated based on only considering a few target species or a few species of special concern. However, in mixed species fisheries this can lead to ignoring a major fraction of the catch when evaluating the impact of the fishing activity and/or the use of a specific gear design in the fishery. One such example is found in the demersal trawl fishery in the Bay of Biscay. Therefore, for the first time we adapted and used a newly developed method to evaluate the fishery from a species community perspective by considering all fish species captured. Further, we discriminated between landed and discarded fractions of the catch and made the evaluation based on both number of individual fish captured and on biomass in terms of catch weights. Results showed that, compared to a none-selective codend, the used of the mandory codend increased the dominance of the main targeted species in the catch from 1.8% to 27% when measured in number of fish and from 16% to 44% when measured in biomass demonstrating the benefit of the selective gear. However, even with the use of selective gear, only 64% of the total number of fish captured is landed, demonstrating an unintended impact on the ecosystem.

3.4 Session 4: Discard Survival

(18) Discard survival and fish quality improvements by using a Modular Harvest System (MHS) in demersal beam trawl fisheries

Pieke Molenaar[1], Alessa Mattens, Lennert van de Pol & Edward Schram

[1] *Wageningen Marine Research*

Demersal tickler chain beam trawl fishery targeting sole (*Solea Solea*) in the North Sea catches substantial amounts of undersized plaice (*Pleuronectus platessa*). Our captive observation studies show that only 8% of these plaice survive being caught and discarded. To increase discard survival probability and improve fish quality and catch welfare a Modular Harvest System (MHS) was customized for the Dutch beam trawl fishery. The Modular Harvesting System (MHS) is a novel cod-end originally developed in New Zealand by Precision Seafood Harvesting Limited,

Timaru, New Zealand to reduce fish damage during trawling, haul back and unloading. The MHS is a membrane-like fabric tube with escapement holes that replaces the mesh lengthener and cod-end of a trawl. The terminal section of the MHS is non-porous, which allows fish to be lifted aboard in a fluid environment. This and the graded flow reduction and open geometry of the MHS reduces fish damage during trawling, haul back and unloading. The openings in the escape module are tailored to retain sole above its MCRS size (24 cm). This study investigated whether the MHS improves capture conditions with as a result better marketable fish quality and significantly higher discards survival.

During six 4-day trials the performance of the MHS was compared to regular 80mm mesh trawls on a small and large commercial vessel by replacing one of the two cod-ends of the double rigged beam trawlers by a MHS. In these trials fish condition was assessed using the Reflex Action Mortality Predictor (RAMP) combined with scoring external damage. Those two methods provided insights in the differences in damage and exhaustion between MHS and mesh caught fish. During two trials survival of undersized sole, plaice and turbot was measured by captive observations. For all tows marketable catch weights were compared.

Underwater camera footage collected during trawling clearly shows turbulent conditions in the traditional mesh trawls and much calmer conditions inside the MHS. This difference results in significantly less damaged fish in the catches, where the RAMP scores show significantly less impaired reflexes for MHS fish. Discards survival measurements show a significantly higher survival probability for turbot and plaice, but not for sole. Quality of the marketable fish caught by the MHS was better. Marketable catches by the MHS were lower in the first trials, but trawl optimalization resulted in higher marketable sole catches in the last experimental week and equal catches for all other species. Overall discard quantities were reduced by 15% compared to conventional 80mm mesh cod-ends. The MHS has shown to be suitable to improve fish quality and discards survival without compromising landings of marketable fish. Future work will focus on legalization, endurance experiments and application in other European fisheries.

(19) Survivability of spurdog (*Squalus acanthias*) caught in the Irish demersal trawl fishery

Martin Oliver[1], Ross O'Neill[2], Matthew McHugh[1], Daragh Browne[1], Shane Murphy[3], Cóilín Minto[3] & Ronán Cosgrove[1]

[1] *Bord Iascaigh Mhara*

[2] *Marine Institute, Renville*

[3] *Atlantic Technological University*

We assessed spurdog (*Squalus acanthias*) condition and post release survival in an Irish bottom trawl fishery towards an application for a survival exemption under the EU landing obligation. Fish condition was assessed using a modified five-point scale; excellent, good, poor, moribund and dead based on fish movement and injuries. Survivability was assessed using pop-up satellite archival tags (PSATs). Ten spurdog in excellent and good vitality were tagged and released. Tagged spurdog ranged in size from 80 to 100 cm, this size range was chosen based on the tag requirements and maximum commercial landing size (MXCRS) for spurdog in Ireland. The tags were set to release after 30 days at which point fish were assumed to have survived.

Of 469 spurdog caught during seven trips, 56 (12 %) were between 80 – 100 cm with 77 % of these found to be in excellent or good vitality. 95 % of spurdog > than the 100 cm MXCRS were in excellent or good condition while fish < 80 cm were generally in poorer condition. Nine out of the ten tags popped off after 30 days providing a 90 % survival estimate. Study results suggest relatively high survival of spurdog between 80 – 100 cm and provide supporting information in

relation to the current MXCRS. Further condition assessment work and pop-up tagging of spurdog in poor or moribund condition is planned.

3.5 Session 5: Topic Group Introductions (ALDFG, Multi-Use, Indicators)

(20) ALDFG: Effects of ALDFG on sessile organisms and eelgrass bed

Yoshiki Matsushita[1], Gregory N. Nishihara, Makoto Kabeyama, Alifro Maldini, Chiyo Takahashi & Saranya Raju

[1] *Nagasaki University*

Effects of ALDFG (Abandoned, Lost or Otherwise Discarded Fishing Gear), which constitutes a large portion of benthic macroplastic debris in our study sites, on habitat forming eelgrass and other biological organisms were investigated in Nagasaki, western Japan. A search and recovery study of ALDFGs on the seafloor in an active lobster gillnet fishing area was carried out in 2023. The survey was done by skin diving (June and Oct), deploying an underwater drone (July), and scuba diving (Aug). Divers towed a buoy equipped with a GPS logger to record the approximate location of ALDFGs, which were photographed and recovered. Forty-one ALDFGs were recovered during three diving surveys. Three were gillnets and remainder were netting and ropes. All gillnets were found to be entangled with sea-fans Acanthogorgiidae weighing approximately 1 kg and one small spiny lobster *Panulirus japonicus*. Of the 38 other ALDFGs, 14 were entangled in algae, oyster beds, and hard corals. Although several reports indicate that the ghost-fishing ability of abandoned gillnet decreases rapidly over time, the entanglement of ALDFGs on sessile organisms may continue for longer periods. The second study was done in eelgrass (*Zostera marina*) beds, where benthic litter on the seafloor was removed and collected once a month from 2021 to 2023. At the same time, the cover rate of eelgrass was recorded at 310 points using a line-transect. Most of the benthic litter collected was netting and ropes of fishery origin. The monthly amount of litter collected tended to decrease as removal progressed, and at the same time, the coverage of the eelgrass beds increased. The ALDFG deposited on the seafloor may cover the eelgrass and inhibit photosynthesis or may be buried in the seafloor and interfere with the growth of the rhizomes.

(21) ALDFG: Global inland fisheries: plastic pollution and other conservation challenges

Drake Ssempijja[1,2], Haraldur Arnar Einarsson[3,4] & Pingguo He[1]

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[4] *Marine and Freshwater Research Institute*

This presentation reviews and analyzes current fishing gear types used in global inland fisheries, with emphasis on their conservation challenges, regulatory mechanisms, and the potential to cause plastic pollution. Forty-nine studies published between 2003 and 2023 are included in this review. There are thirty-six gear types in use in world's inland fisheries according to the Revised International Standard Statistical Classification of Fishing Gears (ISSCFG). It was observed that

inland fisheries are multi-gear and multi-target fisheries during different fishing seasons, with set gillnets being the most common fishing gear type. On conservation challenges, the review showed evidence that links inland fishing gear to environmental destruction and degradation that lead to biodiversity loss, overexploitation, ghost fishing, bottom impact, bycatch, and habitat destruction. Factors that may contribute to plastic pollution from ALDFG in inland fishing gear include mode of operation, open access nature, level of enforcement, and material used for fishing gear. The main regulations for inland fishing gear are mesh size limitations, banning of specific gears, and closed seasons. The future of inland fisheries depends on using sustainable fishing gear types and practices, enhanced fisheries resource monitoring and assessment, and creating a conducive policy and regulatory environment that reduces plastic pollution and other environmental impacts.

(22) Multi-Use: Staying in your lane: scaled images of mobile fishing gears in U.S. offshore wind arrays

Mike Pol[1]

[1] *Responsible Offshore Science Alliance*

Development of offshore wind may result in voluntary exclusion of fishing effort from within turbine arrays, particularly mobile gears. Offshore wind developers in the U.S. have attempted to provide adequate spacing for fishing to continue, but fishers for the most part say that safe operation of their gears requires greater distances than those provided. The size and scale of these inter-turbine distances as well as of the individual turbines is quite large: turbine heights can be 850 m from the surface of the water and inter-turbine distances can be 1.3-1.8 km. To aid discussion of gear-related issues related to access, scaled 2-dimensional drawings were made of three different gear types: demersal otter trawls, scallop dredges, and hydraulic clam dredges. Sizes of gear and rigging were vetted with multiple fishing industry representatives. Drawings appear to show sufficient space for fishing, although fishing practitioners still indicate they will choose not to fish in these areas. This response suggests gear technologists should investigate and develop a better understanding of spatial use by mobile fishing gears and vessels both at the surface or at the bottom to attempt to provide deeper insight of their spatial needs.

(23) Multi-Use: A global assessment of fishing within offshore windfarms to inform recommendations for Ireland marine spatial planning process

Elizabeth Tray[1], Shane Murphy[2], Cóilín Minto[2] & Ronan Cosgrove[1]

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Globally, governments have committed to decrease reliance on fossil fuels and increase renewable energy generation. To date, Ireland has 59 offshore wind farm (OWF) applications in preplanning stages, with a further 6 projects recently expedited by government to reach full commissioning by 2030. These developments will occupy marine space which is currently the source of Ireland's 1.26-billion-euro seafood sector. Research has broadly examined OWF impacts on ecology, socioeconomics, fisheries, etc., although no global analysis of fishing activity occurring directly within operational OWF's exists. To date, there are approximately 300 OWF's reported as fully operational in the marine environment. This study aims to investigate these OWF site footprints and frequency of fishing within their spatial extents to reveal infrastructure design, legal, and operational factors which may be conducive to coexistence. The methodology utilizes both open source and proprietary datasets and includes a statistical spatial overlap assessment.

The results will identify key barriers or enablers which facilitate coexistence and ascertain real life factors which compound spatial squeeze in the marine environment. Implications and recommendations for Ireland's developing OWF industry & marine spatial planning process will be discussed.

(24) Indicators: Fisheries ecolabels and FIshing Gears Indicators (FIGI): overlap, synergies and future directions

Valentina Melli[1]

[1] *Technical University of Denmark, National Institute of Aquatic Resources (DTU Aqua)*

Fisheries ecolabels, such as the Marine Stewardship Council (MSC), utilize comprehensive indicators-based systems to assess the sustainability of fisheries prior to and during their certification. These indicators-based systems typically encompass a range of ecological, social, and governance criteria to evaluate the environmental impact, management practices, and community involvement of fisheries operations. In particular, the MSC fisheries standard is based on three overarching principles:

Principle 1: Sustainable fish stocks.

The fishing activity must be at a level which is sustainable for the fish population. Any certified fishery must operate so that fishing can continue indefinitely and is not overexploiting the resources.

Principle 2: Minimising environmental impact.

Fishing operations should be managed to maintain the structure, productivity, function and diversity of the ecosystem on which the fishery depends.

Principle 3: Effective management.

The fishery must meet all local, national and international laws and must have a management system in place to respond to changing circumstances and maintain sustainability.

As fishing gears technologists, Principle 2 is particularly relevant to us as it includes indicators to assess the impact of the fishery on a range of ecosystem components, including non-target species, endangered, threatened and protected (ETP) species, and habitats. Therefore, this talk will focus on identifying the overlap and potential synergies between the indicators used to certify a fishery and the FIshing Gears Indicators (FIGI) that we use to quantify the performance and impact of a given fishing gear. Moreover, we will discuss the role that recent technological developments (e.g. electronic monitoring, underwater sensors and cameras) could play in the future of fisheries ecolabels, as they allow to assess the performance and impact of a fishing gear at the vessel, single fishing trip, or even single deployment level.

(25) Indicators: An indicator based, voluntary assessment scheme enabling transition towards a more sustainable fishery

Lancelot Blondeel[1], Ellen Pecceu[1], Katrien Verlé[1], Els Vanderperren[1] & Hans Polet[1]

[1] Institute for Agricultural and Fisheries Research (ILVO)

The Belgian fishing fleet, mainly composed of beam trawlers, has faced numerous challenges in the past decade. High fuel prices led to economic hardship, competition for space at sea encroach on the known fishing grounds (windfarms, MPA's, Brexit), and the use of beam trawls is criticized for its lack of selectivity and the large impact on the marine environment. The beam trawl also limited the possibility of obtaining certification through initiatives like MSC which puts

fishers at risk of losing market access. Additionally, fishers were wary of interference from fisheries management and scientific institutions, limiting constructive exchanges between stakeholders.

To meet these challenges, Belgian stakeholders decided to develop a sustainability assessment tool called VALDUVIS which utilises 10 indicators to monitor the social, economic and ecologic progress of the Belgian fleet. This system is currently used to guide the Belgian fishers to further improve their scores through a voluntary fishery improvement program. The aim has been to apply a step-by-step approach with progressively increasing thresholds for participation and to gradually convince and prepare fishers to change their current practices. This would enable the entire fleet to evolve into a more sustainable direction that would benefit everyone in the long term.

Early on, motivating vessel owners to participate proved to be difficult, with only 3 of the 65 vessel owners showing interest in the initiative. A change of heart came with the introduction of a market recognition, which was awarded to those who achieved a set minimum score and declared to participate in the improvement program. Consequently, participation increased to 51 vessel owners in one year.

We explore how the indicators of the fishery improvement program (Visserij Verduurzaamt) translate to a market recognition that motivates vessel owners to participate in the FIP. Additionally, attention will be given to the two ecological indicators that try to estimate the impact of the fishing gear on the benthic environment and selectivity.

3.6 Session 6: Human Behaviour

(26) Advancing the uptake of proven fishing gear: an update

Mike Pol[1]

[1] *Responsible Offshore Science Alliance*

A 2016 WGFTFB Topic Group on Application of Change Management in the Fishing Industry began exploring the process of uptake of proven fishing gears. A successful publication based on that exploration documented how much remains to be learned or understood regarding facilitating or improving uptake. Since that time, progress has been made on incorporation of the skills and tools of social scientists, in addition to the continuing development of models of human behaviour, including the production of a Themed Set for the ICES Journal of Marine Science partly dedicated to this specific topic. Of the eighteen articles in the set, seven investigated the behaviour of fishers and applied existing or novel models to deepen understanding of motivations and incentives to change; little overlap among theories was found, and more and deeper consideration of this topic is needed. This presentation will highlight the lessons learned from the Themed Set on uptake of proven fishing gears.

(27) Investigating the barriers and challenges for UK fishers in taking up more selective fishing gears to avoid unwanted catches

Thomas Catchpole[1], Marieke Desender[1], Stuart McLanaghan[2] & David Warwick[2]

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[2] *Seafish (www.seafish.org)*

PART I - The sustainability of many fisheries could be improved by reducing the catches of marine animals other than those targeted by fishers. However, effective tools, techniques and

strategies to improve the selection of commercial catches frequently seem to be overlooked or unused (Pol and Maravelias, 2023). Voluntary as well as mandatory approaches, including bottom-up or fishers' led initiatives, have had mixed success in the implementation of more selective gear to avoid unwanted catches. This study investigates what possible barriers might need to be overcome to encourage the uptake and implementation of more selective fishing gears for the UK fishing industry. This was done in two stages: firstly, a targeted review of literature was conducted, focusing on the recent publication "Challenges to incentivizing avoidance of unwanted catch" (Pol and Maravelias, 2023); and secondly, an online questionnaire survey, utilising the findings from the review, was jointly designed by Cefas and Seafish and delivered to UK fishers, through their regional / national bodies. The findings from the literature review and the survey of fishers were combined to make some overarching conclusions and recommendations presented here. These also informed the design of a project to encourage uptake of more selective trawl designs in the English northeast Nephrops (*N. norvegicus*) fishery. An abstract has been submitted to present this project - PART II.

(28) Road test selected trawl designs in the English northeast Nephrops (*N. norvegicus*) fishery

Samantha Stott[1] & Thomas Catchpole[1]

[1] *Centre for Environment, Fisheries and Aquaculture Science*

PART II- Improving selectivity is the most effective way of reducing catches of marine animals other than those targeted by fishers and will contribute to reducing handling costs for unwanted catches. However, uptake of more selective fishing gear is often associated with a risk of investing in unsuitable trawl designs and of losing marketable catches. This study provided an opportunity for a group of skippers working in the English northeast Nephrops (*N. norvegicus*) trawl fishery to 'road test' preferred trawl options, selected from a 'show room' of designs that have demonstrated potential to reduce unwanted catches in limited scientific trials. In this study, eight skippers led in selecting and testing the trawl designs under commercial conditions for a sufficient time to gain experience and confidence in the designs. The tested designs included coverless trawls, separator trawls and large escape panels in the trawl. Furthermore, skippers were given the opportunity to record information on the performance of the trawls which was then analysed to evaluate whether the trawls had demonstrated a reduction in unwanted catches. The findings of this study are presented here. This study built on the recommendations from the study investigating the possible barriers on the uptake of more selective fishing gears for the UK fishing industry (PART I). An abstract has been submitted to present this project - PART I.

(29) Moving forward: Australia national extension officer network facilitating change in the fishing and aquaculture industry

Steve Eayrs[1], Jamie Allnut, Nathan Bicknell, Kris Cooling, Felicity Horn, Matt Jones, David Maynard & Lauren Thornton

[1] *Fisheries Research and Development Corporation*

In 2022, Australia's Fisheries Research and Development Corporation (FRDC) established a national extension officer network (EON) for the purpose of extending research and development outcomes to stakeholders, bringing stakeholders together to tackle issues, and to identify research needs suitable for FRDC funding. Fundamentally, the Extension Officers (EO) have agency to facilitate change in the fishing and aquaculture industry, with one appointed in each Australian state and territory.

With a focus on recent revolutionary changes to the Queensland East Coast Otter Trawl Fishery and East Coast Inshore (net) Fishery, this presentation will describe the EON and provide examples of their impact to date, guided by a fundamental theory of change. It will also highlight how such a network can help overcome extension and outreach challenges to facilitate change, including those identified in the WGFTFB Change Management in Fisheries Topic Group (2015-17) such as reliance on researchers to achieve this outcome, inadequate communication, and poor voluntary adoption of proven R&D outcomes. The challenges measuring the performance and impact of the EON's extension efforts will also be discussed.

(30) Increasing uptake of the Ultra Low Opening Trawl (ULOT) in the New England (USA) Groundfish Fishery

Aaron Whitman[1] & Stephen Eayrs[2]

[1] *Gulf of Maine Research Institute*

[2] *Smart Fishing Consulting/Fisheries Research and Development Corporation*

Despite having successfully demonstrated the Ultra-Low Opening Trawl (ULOT) in research trials, reducing Atlantic cod (*Gadus morhua*) by 46.8%, there has been little uptake in the New England groundfish fishery for the ULOT. To increase the uptake of the ULOT we received funding to have nets custom built for five fishers along will be compensated for using the net and providing feedback for outreach materials. We utilized a scientific communication specialist from the Gulf of Maine Research Institute (GMRI) to create a targeted ad on Facebook for our program. Through this method, we received more applications and interest in a cooperative research project in two weeks than we have ever had before. In total we received 29 applications to the project with over 1,000 clicks onto our link, reaching over 13,000 individuals, all for the low cost of $0.12 per click. We believe that this method is an effective way to reach your intended audience and increase fisher participation in projects as well as spread information about your results.

(31) Economic viability of new passive fishing methods for brown shrimp (*Crangon crangon*) in the Dutch Wadden Sea: a business-economic approach

Edward Schram[1], Pieke Molenaar[1], Marc Robert[2] & Kees Taal[2]

[1] *Wageningen Marine Research*

[2] *Wageningen Economic Research*

New fishing methods not only need to be technically feasible, but they should also provide viable business cases. Technical performance of new fishing methods thus needs to be placed in a business-economic perspective. For this purpose, we develop a generic bio-economic model. We will use this model to evaluate two alternative passive brown shrimp fishing methods in the Dutch Wadden Sea: stow nets and pots. Passive shrimp fishing methods for the Wadden sea become of increasing interest because the traditional beam trawl fisheries for shrimp are under debate for their fuel consumption, emissions, seafloor disturbance and bycatch of juvenile fish inside a UNESCO World Heritage site. Shrimp fisheries with stow nets and pots will be tested and optimized by fishermen supervised by scientists over a period of 12 months to account for seasonal variation in catches. Data collection will include catches (landings & discards), catch compositions and operational aspects and costs.

Both passive methods are likely to catch fewer shrimp than active methods like beam trawls but may still provide viable business cases for fishermen provided costs are also substantially lower. The bio-economic model will place the realised catches and associated fishing efforts in a

business-economic perspective. Model input will include operational expenses, capital expenditures and gross income generated by the fisheries. Model output will include total investments, break-even, internal rate of return and cost price.

Different scenarios will be evaluated, such as the comparison between newly commissioned electric vessels and adapted existing vessels, seasonal fisheries combined with other activities compared to full-time fisheries, or the impact of various effort levels (e.g. the number of pots used and days at sea). Sensitivity analyses will be conducted to reveal which variables predominantly determine economic viability. Economic performance and realized catches will be compared to traditional shrimp beam trawling. All this will allow us to evaluate under what conditions either passive fishing method provides a viable business case for shrimp fishermen.

3.7 Session 7: Fish Behaviour

(32) Time for action: a plea for establishing quo vadimus on the future relevance of animal behavior in the development of sustainable fisheries

Junita D. Karlsen[1]

[1] *DTU Aqua*

It is widely recognized that fishing gears are designed to influence animal behavior to maximize capture. The first descriptions of species-specific differences in responses to trawl inspired a large range of gear modifications to avoid retention of unintended catch. During the last couple of decades, sophistication of our understanding of animal responses in fishing contexts has been called upon to accelerate the development of efficient gear modifications. Recent expansion in the range of gear modifications required to develop sustainable fisheries and increased focus on animal welfare in conjunction available technologies to digitize the catch process, makes understanding animal behavior during the capture processes more relevant than ever before.

Through a range of examples from a literature case study, the aim is to critically review how animal behavior has been studied, reported, and referenced. Emphasize will be on the collected data supporting the interpretation, understanding, and use of different observed behaviors. The results will be used to highlight potential barriers to future improvements in understanding behavior. Recommendations to limit these barriers are given, but it is prudent to identify the future framework of animal behavior in the development of sustainable fisheries.

(33) Optimizing fish pot design for targeting flatfish: a two-phase approach to enhance efficiency

Sara Berzosa[1], Thomas Noack[1], Andreas Hermann[1], Andrea Milanelli[1], Uwe Lichtenstein[1] & Daniel Stepputtis[1]

[1] *Thünen Institute for Baltic Sea Fisheries*

Gillnets are a popular fishing gear worldwide due to their effectiveness, ease of handling, and affordability. They are also considered sustainable, characterized by low carbon emissions, selective targeting of specific species, and low impact on seabed habitats. Nevertheless, their contribution to marine mammal and seabird bycatch presents significant conservation challenges. To mitigate bycatch, transitioning to alternative fishing gear, such as fish pots and traps, offers a potential solution. However, further research is needed to improve the catchability of fish pots. To improve the catch efficiency of fish pots by opening the fishery up to new target species, this study investigates different entrance designs for flatfish using a two-step approach. In the first

phase, understanding flatfish behaviour and interaction with the gear is essential. In semi-controlled conditions of a net pen, we tested different entrances and recorded the behaviour of the fish using infrared cameras and light to understand how the fish enter and exit. In the second phase, we validated the efficacy of the identified optimal entrances under commercial conditions. Collaboration with experienced fishers can facilitate field testing and provide valuable insights into the practical applicability of the modified fish pots. The initial results from this study, which will be presented, provide valuable insights for improving the design and development of fish pots, contributing to their effectiveness in capturing a diverse range of species while minimizing environmental impact.

(34) Bridging missing links in fish attraction to lights through field and laboratory studies

David Gauld[1], Chris Rillahan[1] & Pingguo He[1]

[1] *School for Marine Science and Technology, University of Massachusetts Dartmouth*

It is well known that many species of fish are attracted to light under various conditions. There are several hypotheses on why fish are attracted to light, but the behavioral mechanisms which drive fish attraction to light are not well understood. Previous research on the application of light attraction in fish capture has focused on whether a fish or crustacean is attracted to a certain color of light but not on why and how fish are attracted to light. We conducted both field and laboratory studies to understand why fish are attracted to light. The field work recorded and compared fish attraction to different colors of light using a camera and a high-resolution imaging sonar at night. The laboratory component compared fish attraction when in filtered water and when zooplankton were added to the filtered water in a large tank. Field results showed that Scup (*Stenotomous chrysops*) were attracted to green light. In the laboratory, scup showed little attraction to lights of any color in a filtered seawater environment but when small invertebrate prey was added into the tank an attractive effect was induced. These findings suggest that for scup light attraction may not be based on the light itself, but instead may be due to attraction of small aquatic invertebrates that scup might be feeding on. There may be more than one species or species group along the food chain that are attracted to the light, inducing an attractive effect on their predators. Research on the missing link will help our understanding of the mechanisms of light attraction, and seasonal and spatial variations in light attraction.

(35) Snow Crab Vision Fishing Gear, Phosphorescence, and the Environment

Colin Frank[1], Shannon Bayse[1,2], Rioghnach Steiner[1] & Pierre-Paul Bitton[2]

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[2] *Cognitive and Behavioural Ecology (CABE), Memorial University of Newfoundland*

This study explores the visual abilities of snow crab (*Chionoecetes opilio*) concerning their interaction with phosphorescent-netting pots used in commercial snow crab fisheries. Light emitted from such pots increases catch per unit effort, yet little is understood about the factors driving these higher catch rates. In this study, we measure pot light emission and snow crab acuity. Combining these data with estimates obtained in the literature for other biotic and abiotic factors, we model snow crab vision in relation to the pots. Utilizing these factors and environmental conditions, we find the photon flux of the pots and derive a contrast ratio between the pot light and the ambient light. Findings reveal that the visibility of pot lights at a 200-meter depth depends primarily on solar angle (time of day) and time elapsed post-deployment. Additional factors influencing the vision of the pots include water column quality and benthic boundary layer

turbidity. This study is the first to model the visual ecology of snow crab and the first study to estimate snow crab acuity. These insights into snow crab visual ecology can enhance fishing techniques, promote catch efficiency and sustainability, and help provide a path forward for visual ecology research in the fisheries science field.

3.8 Session 8: Innovative Gear

(36) Innovative fishing gears

Antonello Sala[1]

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In the ICES Workshop on Innovative Fishing Gear (WKING2) in August 2023, fishing technologists and other individuals involved in the development of the innovative fishing gear were requested to complete a new factsheet for any newly developed innovative fishing gear. The purpose of WKING2 was to:

a) Evaluate/endorse the catalogue of gears considered 'innovative';

b) Assess the level of uptake of innovative gears by the EU industry (per sea basin and fishery) that are ready for deployment, investigate aspects that impact the uptake of innovative gears including finance, user-friendliness, health, and safety;

c) Discuss the main drivers that prevent their use if known, and where possible, include analysis of the socio-economic trade-offs and propose ways to facilitate their implementation;

d) Produce a report detailing the process taken and presenting the results;

e) Draft summary advice based on the report produced.

The performance criteria used in the WKING2 report, their definition, and their underlying assumptions must be considered more deeply from a wider audience before any future steps are taken to replicate the report. We made several assumptions based on our knowledge and long history of experience with the commercial fishing sector. While we are comfortable with the assumptions, and have justified them, they are subject to our personal bias. A dedicated effort such as an ICES WGFTFB Topic group would be a useful next step. Such an effort could also be responsible for deliberating on appropriateness or otherwise of the array of criteria used in this report, their definition, and the coarse and limited ranking of each performance criteria. It is requested to present the insights from the WKING2 as well as propose a new Topic Group for the next three years.

(37) A: Selectivity design for the Modular Harvesting System, a non-mesh codend

Damian Moran[1], Si Thu Paing[1] & Martin de Beer[2]

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[2] *Precision Seafood Harvesting (New Zealand) Limited*

The Modular Harvesting System (MHS) is a membrane-like fabric tube with escapement holes that replaces the mesh codend of a trawl and is designed to reduce damage to catch by providing fish a low-flow, low-turbulence environment that allows them to maintain swimming control and avoid compaction during trawling and haulback. Despite the MHS material having a low porosity compared to mesh, the MHS can achieve comparable size selectivity characteristics to mesh codends due to the way it hydrodynamically inflates and the stable geometry of the

escapement holes. In this presentation we discuss the design of escapement holes of MHS units that have been used to target fish with different morphologies, together with studies on the size and species selectivity of various MHS designs versus mesh codends. Size selectivity for the MHS is generally more knife-edge than for mesh codends, with flow-on effects to factors such as fishing efficiency and fisheries population management. The mechanisms of fish escapement from the gear are broadly understood, though the relative importance of active versus passive selection are still being determined.

(37) B: The behaviour of fish in the Modular Harvesting System, a non-mesh codend

Damian Moran[1], Glen Aspin[1], Si Thu Paing[1] & Martin de Beer[2]

[1] *New Zealand Institute for Plant and Food Research Limited*

[2] *Precision Seafood Harvesting (New Zealand) Limited*

When fish herded by trawl nets enter the Modular Harvesting System (MHS) they encounter a low-turbulence environment with graded water velocities and space to allow them to maintain swimming control and avoid compaction during trawling and haulback. In this presentation we discuss the velocity and turbulence profiles within different MHS codends using computer modelling and in-trawl measurements, together with a review of how fish with different swimming styles and morphologies behave in this environment. Allowing fish to maintain swimming control is critical to enabling both active and passive selection through the escapement holes, and examples will be shared where understanding fish behaviour has been used to improve the selectivity of the MHS, as well as understanding causes of damage and product down-grading. Allowing fish to maintain swimming control has enabled skippers to adopt new fishing strategies with the MHS, such as long duration trawls and capture plus storage-at-depth while waiting for processing lines to clear aboard factory vessels. Examples of these skipper-driven fishing strategies will be discussed along with images of fish quality from 5â€“13 hour trawl durations.

(38) Ibero-American Network for the Study of Bycatch and Discards *[Presented during the Business Meeting]*

S. Dans, M.E. Gongora, M. SanMartin, L. Clavijo, V. Iriarte, P. Rosero, E. Secchi, D. Monteiro, L. Coccus, J.C. Baez & M.A. Hall

Red para el estudio de Capturas Incidentales y Descartes - redCID (Network for the Study of Bycatch and Discards)

The study of fisheries bycatch and discards is critical in achieving the goals of sustainable fisheries and ecosystem conservation. Those interested in these subjects in Ibero-America have experienced limitations when it comes to regional communication and attending international conferences. This was due to language barriers, economic limitations and, more recently, COVID-19. In order to facilitate the regional interaction and integration, a network to study fisheries bycatch and discards was initiated in 2021. The name of the network is redCID (Red para el Estudio de Capturas Incidentales y Descartes) and includes researchers, technologists, fishers, and others. The network is a virtual space for open and creative discussions and is based on individual participation–expressing ideas on a personal basis rather than an institutional one.

These meetings focus on collaborative solutions and embrace local experiences and practical knowledge. RedCID makes a special effort to involve the artisanal fisheries that are so significant in this region. Because of the economic conditions, there are excellent opportunities for experimental research on gear and devices. The network neither positions itself nor assumes the representation of its members, which encompass a range of stakeholders, including fishers, managers and researchers.

RedCid's has 252 members (116 women, 136 men) from 19 nationalities. The majority of members are biologists/ecologists (77%), followed by fisheries engineers (13%). Others includefisheries managers and veterinarians. Average attendance over three years has been 38 attendees with an average of 91 subsequent views. The network meets once per month online, operating in Spanish or Portuguese. Since its launch, the network has organized 38 webinars,virtual workshops and conferences which are then published in RedCid's YouTube channel (https://www.youtube.com/@redcapturasincidentalesyde5275). Topics discussed have included community-based strategies, discard management, spatial approaches, habitat models, fishing gear mitigation technology and workshops for fishers on handling and release techniques.

(39) Fisheries in transition: researching innovative bait and novel potfishing opportunities

Jasper Van Vlasselaer[1] & Mattias Van Opstal[1]

[1] *Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences – Fisheries*

Beam trawling in the North Sea is encountering significant pressures from political, socio-economic, and environmental dimensions. Declining revenues resulting from diminished catches, quota constraints, and spatial limitations compel fishers to either adapt or face economic demise. A potential avenue for adaptation lies in transitioning towards alternative fishing methodologies such as pot fisheries. In support of this transition, our research explores possibilities of pot fishing for economically significant species, with a particular emphasis on employing innovative baiting strategies, such as light and odors to attract target species.

Our current investigation focuses on four commercially important species: the brown crab (*Cancer pagurus*), the brown shrimp (*Crangon crangon*), and two species of flatfish, sole (*Solea solea*) and plaice (*Pleuronectes platessa*). The brown crab is traditionally captured through trawling and pot fishing methods, with pot-caught specimens having a better quality. For this species, we are evaluating the efficacy of light stimulation as a means of augmenting crab catch rates, while also investigating whether crabs are drawn to pots primarily for feeding or sheltering. For brown shrimp (*Crangon crangon*), little knowledge exists regarding effective attractants or pot-fishing methodologies targeting this species. Within our laboratory, diverse baiting strategies and pot designs are under evaluation, contributing to the development of a novel and sustainable fishery. We are also investigating whether we can attract flatfish into pots, as sole and plaice represent the primary targets for beam trawling activities. While light stimuli demonstrate limited efficacy, olfactory cues emerge as promising avenues for pursuit.

In summary, our investigations into novel baiting approaches, encompassing both light and odors, seek to facilitate a transition from beam trawling to pot fisheries for diverse commercially valuable species. By elucidating the dynamics of attraction and behaviour, our efforts contribute to the development of a resilient and forward-looking fishing industry.

(40) Survey dredges do not sample well in high-density scallop grounds: New evidence from high-definition cameras

Christopher Rillahan[1], Sally Roman[2], David Rudders[2] & Pingguo He[1]

[1] *University of Massachusetts Dartmouth*

[2] *Virginia Institute of Marine Science*

The Atlantic Sea scallop, *Placopecten magellanicus*, fishery is one of the most valuable fisheries along the US East Coast with an ex-vessel value in excess of $670 million USD from a landing of 19,631 mt of scallop meat in 2021. The fishery is typically supported by several surveys (i.e.,

dredge and optical surveys) which provide multiple, spatially explicit annual biomass estimates. From 2015 to 2022, significant divergence in area specific biomass estimates were noted between the different survey methods, where optical survey estimates were greater than dredge estimates in areas of high scallop density. The main theory for these differences is that the dredge may have saturated during the standard 15-minute tow in high-density areas. The objective of this study was to assess the influence of scallop density on dredge efficiency (q). High-definition cameras were placed on the dredge to enumerate the number of scallops in the dredge path. Estimates of efficiency were derived by comparing the number of scallops in the dredge path to the number collected in the dredge bag. Additionally, the behavior and capture of bycatch species were examined. The estimated dredge efficiency for sea scallops was observed to decline with increased scallop density. At low densities, q estimates were similar to those reported in the 2018 stock assessment (0.4). As densities increased q declined to 0.09, indicating gear saturation. This finding suggests that the assumption of static catchability is invalid and needs to be adjusted to account for high density scallop aggregations.

(41) KingGrid: An innovative design paradigm for rethinking sorting grids

Juan Santos[1], Frederik Furkert[1], Daniel Stepputtis[1] & Annika Brüger[1]

[1] *Thünen Institute of Baltic Sea Fisheries*

Sorting grids are commonly used in crustacean trawl fisheries to reduce by-catch by preventing unwanted species from entering the codend. While sorting grids can provide well-defined and efficient catch separation, their implementation in commercial fisheries can be difficult, particularly if the design of the grid is not optimised to address practical implementation challenges. This was the case in the North Sea beam trawl fishery targeting brown shrimp (*Crangon crangon*). In this fishery, sorting grids and sieve-nets are the two alternative technologies available and mandatory to the fishermen. However, steel grid designs originally proposed didn't meet the needs of the fishermen, and were never commercially adopted, while sieve-nets became the prevalent technology. However, in recent years and specially during summer season, the use of sieve-nets has become unpractical due clogging issues linked to increased occurrence of algae and/or benthos invertebrates. Recognising the current need for efficient alternatives to sieve-nets, we have rethought the potential of sorting grids I the fishery through an innovative design paradigm that aims to deliver efficient, problem-focused solutions while addressing the practical challenges that can hinder the commercial adoption. Based on such design paradigm, herein we introduce the so-called KingGrid. The KingGrid is a 80x60 cm rectangular grid concept made from polycarbonate material which, combined with its functional design, results in a lightweight, mechanically flexible and robust device. It is designed to facilitate the transport of algae, benthos organisms and debris out of the net and is easy to access and clean, especially when compared to sieve-nets. The KinGrid is built using a simple modular assembly process, making it easy for fishermen to repair and to adjust the bar spacing to suit their preferences and changing regulations. Based on a paired-gear experiment, we investigated the sorting efficiency of the KingGrid with different bar-spacings, and compared it with the sorting efficiencies of traditional grids and a standard sieve-net with a nominal mesh opening of 60 mm. Using the KingGrid with a bar-spacing of 12 mm (8 mm below the maximum allowed bar-spacing in the fishery) led to an average catch efficiency of the targeted shrimp above 90%, a value comparable to the catch efficiency obtained with the standard sieve-net. On the other hand, using the 12 mm bar-spacing resulted in cleaner catches compared to catches obtained with the sieve-net, suggesting improved by-catch-reduction capabilities. Moreover, the KingGrid outperformed traditional sorting grids in terms of sorting efficiency, ease of handling, stability and robustness. Several KingGrid units have been already transferred to the fishery and intensive commercial trials are expected during summer under challenging fishing conditions. We believe that by adopting the KingGrid design

paradigm, sorting grids can become a viable solution in any trawl fishery with similar bycatch problems.

(42) Developing techniques to reduce Greenland shark bycatch in Northern shrimp trawls

Sidney Andrade[1], Shannon M. Bayse[1], Morgan Snook[2], David Kelly[2], Paul. D. Winger[1], Harold DeLouche[1] & Tomas Araya-Schmidt[1]

[1] *Fisheries and Marine Institute, Memorial University of Newfoundland*

[2] *Hampidjan Canada Ltd.*

Greenland sharks (*Somniosus microcephalus*) are captured as bycatch in Northern shrimp (P*andalus borealis*) bottom trawls by becoming stuck in the Nordmøre grid system in certain instances. Thus, an additional bycatch reduction device (BRD) should be considered to ease Greenland shark's escape from the trawl. This study used underwater videos to understand the interactions of Greenland sharks with the grid system and evaluated the information to develop alternative trawl designs. Video analysis showed that the grid system opening was too small and disturbed Greenland sharks' escape. Thus, two experimental trawls were designed with: 1 – a sieve panel with a large exit opening attached before the grid system; and 2 – an increased exit opening (2.5 m) at the grid. Catch comparison methods were employed to test the treatment's effectiveness. Northern shrimp carapace length (CL) ranged between 12 and 27 mm, with 15-, 20-, and 24-mm modes. In the sieve panel treatment, the control caught significantly more shrimp between 19- and 24-mm CL, however, catch proportion differences were <3.5%. In the large opening treatment, the control caught significantly more shrimp for 25- and 26-mm CL but catch proportion differences were <1.0%. Overall, experimental treatments had a small Northern shrimp loss, hypothetically promoting an easier escape for Greenland sharks. However, further studies are needed to evaluate how the experimental designs affect the escape of Greenland sharks.

(43) Effective techniques to develop a sustainable redfish fishery in Canada

V.Y. Nguyen[1], S.M. Bayse[1], P.D. Winger[1], H. DeLouche[1], G. Legge[1], Z. Cheng[1] & G.E. Kebede[1]

[1] *Fisheries and Marine Institute, Memorial University of Newfoundland*

Two effective techniques have been developed for an emerging redfish (*Sebastes* spp.) trawl fishery in the Gulf of St. Lawrence, Canada. Firstly, a shaking codend was developed to reduce the bycatch of small redfish in the catch. We attached an elliptical-shaped piece of canvas to the back of a T90 codend, and its movement and fishing characteristics were tested in a flume tank and field experiment compared to the T90 codend without canvas. The results from the flume tank test showed that the shaking codend had a higher amplitude ratio, period (1 revolution), and total acceleration than the T90 across all flow velocities. Further, a small comparative fishing experiment showed that the shaking codend significantly reduced the capture of small redfish (< 22 cm) and had a better contact probability than the non-shaking T90 codend without canvas. Secondly, a semi-pelagic trawl was developed to capture redfish off the seabed. We applied the French rigging technique to connect the upper bridles of the trawl to the warps, anterior of the trawl doors, leading to the trawl system being fished off the seabed. The results from the first experiment indicated no problems in handing the semi-pelagic trawl and the hauling back process was similar to typical operations. Additionally, the trawl was able to perform effectively on or off-seabed as desired. The capture results, though preliminary during the second experiment indicated that redfish can be targeted commercially with a semi-pelagic trawl and that the catches of bycatch species may be reduced. Overall, these effective techniques developed in

current studies can have potential implications for the development of the emerging redfish fishery in Canada and other trawl fisheries.

(44) Test fishing meeting mechanistically understanding- a case study of gear development targeting the invasive round goby (*Neogobius melanostomus*)

Peter Ljungberg[1], Stefan Eiler[1], Manuel Blanco[2], Anders Persson[2] & Ann-Britt Florin[1]

[1] Swedish University of Agricultural Sciences

[2] Lund University

The round goby (*Neogobius melanostomus*) is invasive to the Baltic Sea. In a three-year project we have investigated the impact of round goby in Swedish waters along with developing and tested new methods for decreasing the negative effect by reducing dispersal and reduce the population along with the potential to capitalize the species. This is of high relevance for management of sea and water since round goby are known to cause negative effects both on aquatic biodiversity and on ecosystem services such as fishery and reduction of nutrients. In order to reduce the round goby, we have developed and tested now passive gear types. Our aim has been on targeting both round goby but also other common species in the Swedish coastal fishery, as amongst others perch (*Percha fluventalis*). Exept for catch efficiency, research have focused on how the fishery could be conducted in a way that the European eel (*Anguilla anguilla*) may be selected from the gear. Moreover, to make our results more viable we conducted lab-based selection and predator-prey interaction trials between perch and round goby to validate our fisheries results. We found the combination of field studies and lab experiments to give a synergistic effect on gear development.

(45) Screw, Snap, Fish: First experiences with a modular and more resilient Pontoon Trap design

Thomas Noack1, Sara Berzosa[1], Andrea Milanelli[1], Uwe Lichtenstein[1] & Daniel Stepputtis[1]

[1] *Thünen Institute for Baltic Sea Fisheries*

Traditional trap nets have long been and continue to be effective and sustainable tools for shallow-water fishing, offering advantages such as live catch retrieval, adjustable selectivity, and minimal seabed impact. The evolution of this method led to the development of pontoon traps, introducing benefits like surface-level catch handling and increased fishing depth flexibility. However, their susceptibility to strong currents and storm events sparked our idea of redesigning them to enhance resilience. Our approach focuses on optimizing the pontoon trap design for robustness against external forces while transitioning from large, rigid components to a modular system. This shift offers several advantages, including easier repairs through the replacement of damaged modular units and efficient storage when not in use. In this presentation, we unveil our novel trap design and share initial insights and experiences gathered from a pilot trial initiated in March 2024 in the southern Baltic Sea. Collaborating with a traditional coastal trap fisher, we aim to demonstrate the practicality and efficacy of our redesigned pontoon trap in real-world fishing scenarios, thereby contributing to the advancement of sustainable and resilient coastal fishing practices.

(46) Embracing new and more efficient fishing gears with focus on their impact on the catch composition

Rikke Petri Frandsen[1], Jordan P. Feekings[1] & Bent Herrmann[1]

[1] *DTU Aqua*

A targeted fishery for lobster (*Homarus gammarus*) is relatively new in Denmark and gears used in the fishery reflects what was already used by the coastal fleet i.e. gillnets, trammel nets, pots and fyke nets. Each gear type has its own set of regulations and preference of gear is area- and season specific, and there is no regulation aiming at restricting catches of juvenile lobsters or bycatches of other species. In 2018 a new trap design was introduced in the Danish lobster fishery. It was imported from China and was given the name "China trap". It can be folded as a fyke net and when unfolded, it consists of a series of chambers, each resembling a creel. Catch rates were good and the gear was easy to store and handle from small vessels. The new gear was therefore readily adopted by the fishery, leaving behind a regulative system that needed an update. A comparative study was conducted to investigate catch rates of the different gears. Furthermore, escape gaps was investigated with regards to their optimal size and shape to match the minimum landing size and the minimum amount needed to allow for an efficient release of juvenile lobsters.

3.9 Session 9: Innovative Gear- Whales

(47) Protecting fish captured on longline gear from removal by whale depredation

Claude L. Dykstra[1] & Ian J. Stewart[1]

[1] *International Pacific Halibut Commission*

Whale depredation of captured fish is a growing challenge among many hook and line fisheries worldwide. In Alaska, both Killer (*Orcinus orca*) and Sperm (*Physeter macrocephalus*) whales are involved in depredation behavior in the Pacific halibut (*Hippoglossus stenolepis*), sablefish (*Anoplopoma fimbria*), and Greenland turbot (*Reinhardtius hippoglossoides*) longline fisheries. Depredation leads to increased costs to fishers, presents challenges to estimating removals for fisheries managers, and can lead to potential risks to whales including physical injury due to being near vessels and gear, disruption of social structure, and developing artificial reliance on non-primary food items. Following a workshop to identify effective methods for protecting hook captured fish from depredation, the International Pacific Halibut Commission recently pilot tested the two most promising designs: (1) an underwater shuttle which removed catch near the ocean floor and securely transported the catch to the surface, and (2) an underwater shroud which slid over a cluster of captured fish to cover them as they are brought to the surface. Key findings and outcomes from the pilot testing will be presented.

(48) Co-existence of species at risk and fisheries through the trial and adoption of on-demand gear

E. Vézina[1] & S. Brillant[1,2]

[1] *Canadian Wildlife Federation*

[2] *Dalhousie University*

In Canada and the US, fishing grounds are being closed to protect critically endangered North Atlantic right whales from the threat of entanglement. Due to the economic and social impacts this management measure has on the fishing industry, a solution must be found that would allow whales and fisheries to co-exist safely. On-demand or 'ropeless' gear has been used effectively for military and scientific applications for decades, but until recently it's application in fisheries has been minimal. Over the past six years, significant efforts have been made to evaluate the suitability of this technology for fixed-gear fisheries. In 2019, the Canadian Wildlife

Federation co-developed an innovative fishing gear trial program with fishing industry partners to evaluate the technology for Atlantic Canadian fisheries (see abstract by Skripsky et. al.). Using the knowledge gained through these trials, we established the CanFISH Gear Lending Program in 2022 to provide access, training, and support to any fish harvesters in Atlantic Canada interested in using on-demand gear in areas closed to traditional fishing to protect right whales. To date, the program has successfully removed more than 500 buoylines from right whale habitat and has helped catch nearly 400,000lbs of marketable snow crab. Additionally, the L'Association des crabiers acadiens has been fishing with on-demand gear for the past three years in Canadian waters. Other organizations in both the US and Canada have been or are becoming involved in the trialing of on-demand gear in fixed-gear fisheries due to increased interest from industry. A regulatory framework is not yet in place to permit on-demand fishing on a broad scale, but recent steps including modifying the Fisheries General Regulations to allow fishing without a surface marker demonstrate a step in the right direction. Continued regulatory development and demonstration of the success of on-demand fishing will be essential to its continued adoption throughout Canada and abroad.

(49) A framework for evaluating on-demand fishing gear suitability for Atlantic Canadian commercial fixed-gear fisheries

S. Skripsky[1], E. Vézina[1], R. Frith[2], K. Urbancic[1], K. Johnson[1], H. Vatcher[1], H. Drake[1] & S. Brillant[1,2]

[1] *Canadian Wildlife Federation*

[2] *Dalhousie University*

To determine its suitability for commercial fisheries, on-demand gear must be trialed under fisheries conditions. In 2019, the Canadian Wildlife Federation co-developed an innovative fishing gear trial program with fish harvesters to establish a method to evaluate this suitability across different on-demand systems and fisheries. Through regional discussions with harvesters, we built a framework that considered operational conditions, expectations of how the gear will function, and a way to measure factors that affect these functions. We implemented this framework in at-sea trials, completing more than 1000 deployments of nine different on-demand systems in snow crab and lobster fisheries from 2019 through 2023. A method of categorizing successful and failed deployments was developed that allowed individual components of each system to be evaluated, improving our ability to identify specific problems. In the interest of improving the suitability of on-demand systems for fishing, we provided this detailed feedback to gear developers on an annual basis. The data collected during these trials allows us to understand how the systems perform in varying environmental conditions and fisheries. Since the beginning of the program, more than 14 commercial harvesters have been engaged in trials throughout the Maritime provinces. These collaborations have been essential for identifying suitable on-demand systems for use in commercial fisheries in Atlantic Canada.

4 Poster session abstracts

On Monday, June 3rd, a poster session was organized so that meeting participants could interact with the presenters. The posters remained up and accessible for viewing over the week. The abstracts are included here (Annex 4).

(A) Result of the fishing gear marking experience in Argentina

Ricardo R Roth[1]

[1] *National Institute of Fisheries Research and Development (INIDEP)*

This work shows the variation on the condition of marks over almost a one-year experience through direct observation and photographic recording, made with marks placed on a bottom trawl net belonging to a vessel engaged in hake fishing. The number of hauls, towing time, and total catch of each fishing day, since the beginning of the experience was obtained from the F/V's fishing reports. Can be seen that from September 14, 2022, when the experience started, to June 13, 2023, when the last review of the marks was carried out, the vessel made 13 fishing trips, a total of 239 hauls, with a time of trawling time of 675 hours and a total catch of 3113.36 metric tons, mainly of common hake (*Merluccius hubbsi*). Because of the net is no longer used, due to its technical condition, and was dismantled, the wing tip markings were returned to the INIDEP Fishing Gear and Capture Methods Development Program. Different figures show the evolution of the marks condition used during the experience. It is concluded that there is the possibility of losing the marks due to snagging, as could be seen in the first review, that the location of the marks must be carefully studied and will depend on the type of fishing gear that is marked and the fishing operation that is carried out. Is made, that metal marks such as those tested, can last as long or longer than the gear where they are used, depending on the conditions of use and location. During the test no alterations or inconveniences were observed in the operation of the trawl gear. Friction of the mark with other elements, such as the seabed, can alter the information recorded on it. Therefore, the possibility of replacing the mark must be analysed, justifying its replacement, if its use is regulated as occurs in provision No. 4/2023 of the National Directorate of Fisheries Coordination and Supervision of Argentina, in which establishes a unique number for each fishing gear.

(B) Spreading a bottom trawl without doors: a proof of concept using flexible foils

Paul Winger[1], Alex Gardner[1], Truong Nguyen[1] & Liam McGregor[1]

[1] *Fisheries and Marine Institute, Memorial University of Newfoundland*

This study documents an engineering proof of concept. We demonstrate that a deep-water bottom trawl targeting Northern shrimp can be spread without trawl doors using nothing more than flexible foils mounted near the wings of the trawl. A combination of numerical simulation, physical modeling in a flume tank, and full-scale sea trials were used to optimize the trawl. Spacing between the kites and the angle of attack to the direction of tow were found to be important parameters. To our knowledge this is the first documented attempt to spread a bottom trawl entirely without doors, using only flexible kites.

(C) Galvanizing crab traps: prolonging lifespan while maintaining snow crab catch

Pete Brown[1], Tomas Araya-Schmidt[1], Terry Bungay[1] & Paul D. Winger[1]

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Commercial harvesting of snow crabs (*Chionoecetes opilio*) began in Newfoundland and Labrador, Canada, in 1967. Today, the fishery consists of 2188 active fishing licenses and has grown into the province's most economically valuable fishery. Snow crabs are captured using conical traps consisting of a mild carbon steel frame, hard plastic entry funnel and a jacket of polyethylene netting. The frames of these traps corrode over time, which is expedited by being deployed in marine environments and stored on land near the ocean when not in use. As a result, there is interest within the community to increase the longevity of crab traps. One solution is to galvanize the steel frames prior to installing the funnel and netting. However, before harvesters transition to galvanized traps, two questions must be answered. Will the use of galvanized steel negatively impact catch rates? Will the life cycle of a crab trap be extended sufficiently to justify the additional cost of galvanizing? This study employed a generalized linear mixed model to evaluate the catch of legal-sized male crabs (CPUE) during the commercial fishery as a function of three trap frame treatments (old traditional, new traditional and new galvanized). We also assessed the economic viability of galvanizing trap frames by evaluating the life cycle cost (LCC) of traditional and galvanized traps to the harvester. The LCC was calculated over a range of inflation (0–6%) and discount (3–20%) rates. Our results found no significant difference in CPUE between new traps (traditional vs. galvanized) and concluded that except during instances of very high discount rates (12.9–19.9%), it is economically favourable to galvanize crab trap frames.

(D) Should I stay or should I go?

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[1] *Swedish University of Agricultural Sciences*

For European lobster (*Hommerus gamamrus*), the conventional gear used is pots, which are typically designed to be efficient for fishing in exploited populations. Mesh size, escape gaps and entrances of the gear limit the size range of potential catch. In a conventional lobster fishery, low selectivity/catchability of the largest individuals of lobsters has no practical effect on total catch as such individuals are extremely rare in exploited populations. However, in monitoring of population size and composition of recovering populations within no-take zones catchability of all sizes are relevant.

This study uses information on size dependent selectivity in combination with in-situ video to reveal size dependent behaviours in and around pots within a no-take zone. Behaviours include both dominant and submissive actions such as aggressions, avoidance, and guarding. Guarding typically occurs by individuals too large to enter the gear and dominant enough to guard the pot for sustained amount of time. In extreme circumstances, guarding may result in zero catch even in areas of high lobster density. In effect monitoring with a too selective gear will contain a strong bias of behaviour to total density estimates as well as the composition of different sizes.

(E) Approaching single-species exclusion in mixed demersal trawl fisheries

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Under a discard ban, mixed fisheries must often reduce catches of low-quota species to allow the continuation of fishing activities. This has led to the development of a range of bycatch reduction devices (BRDs) that aim to exploit morphological and behavioral differences among species to facilitate escape of unwanted catch from the fishing gear. However, the exclusion of unwanted species from the catch is often only possible with concomitant losses of other commercial catches. This is the case for the Nephrops (*Nephrops norvegicus*)-directed mixed demersal trawl fishery, where BRDs aiming at the reduction of catches of cod (*Gadus morhua*) often lead to considerable losses of other valuable species. In this study, we developed and tested a BRD aimed at exclusively reducing cod catches without affecting catches of Nephrops, flatfish and other roundfish. The design, a bottom escape window, exploits behavioral traits that set cod apart from other species. We collected absolute selectivity data using a paired gears approach and estimated the combined retention of the bottom escape window and a 90 mm diamond mesh codend. The results demonstrated a low total retention of cod (33 %) in combination with high retentions of commercial catches of Nephrops (89 %), haddock (Melanogrammus aeglefinus) (76 %) and plaice (*Pleuronectes platessa*) (100 %), for the populations encountered. This catch profile represents an important and novel achievement for Nephrops-directed mixed demersal fisheries. We compared the performance of this new BRD to one of the most used legal gears in this fishery (the SELTRA 270), demonstrated the new catch profile it can offer to the fishers, and discussed its management implications.

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(F) CanFISH Gear Lending Program: a solution to whale closures in Atlantic Canada

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To mitigate entanglement risk to the critically endangered North Atlantic right whale, the Canadian government has been implementing fishery closures since 2018. While effective in removing entanglement threat, this measure displaces fish harvesters, posing economic stress and hardship for coastal communities throughout Atlantic Canada. On-demand fishing gear has been shown to be a suitable method of commercially fishing without buoylines, but barriers to using this gear remain, such as cost, accessibility, training needs, and permitting. To alleviate these barriers, the Canadian Wildlife Federation established the CanFISH Gear Lending Program in 2022 to provide harvesters with on-demand fishing gear and the support required to fish with it in closed areas. CanFISH provides free access to the gear, on-vessel training, and continued on-call support to ensure safe and successful fishing. Pre-season training sessions as well as in-season, on the water demonstrations ensure that harvesters are confident with the technology before using it to fish. Because this gear type uses acoustic, mechanical, and electrical components, proper care and maintenance is essential to ensuring its ongoing success. CanFISH has a team of trained technicians who maintain, troubleshoot, and repair the inventory of 180 on-demand systems regularly. Maintaining a strong working relationship with the system manufacturers has been crucial to the program's success as it ensures the team is well-informed of system upgrades and maintenance procedures. To date, more than 200 harvesters have signed up to use CanFISH if they are impacted by a closure, and 12 harvesters have used the gear to fish commercially. Our comprehensive approach to industry training and gear maintenance ensures that on-demand gear can be an effective solution to whale closures in Atlantic Canada.

(G) Behavioral ecology informs fishing gear design : The case study of Black seabream baited structure

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As a response to an increase demand for more sustainable production of marine proteins, there is a strong need for developing alternative fishing technics to trawling such as commercially viable baited pots. However, these fishing methods have low catch efficiency. Knowledge on animal behavior is a key element to understand and improve the capture processes. Advances in underwater video cameras systems have provided novel tools for researchers and facilitated the observation of species interacting with fishing gears in their natural environment. In this study, using a recently published methodology we quantitatively assessed the effect of external and internal factors on the ingress process of seabreams inside baited structures. Weibull distribution describes the distribution of residence times through time and allows testing the effect of fish length, number of congeners or pots design on ingress rate and the propostion of the population that eventualy enter the pot. We demonstrated size and social effects on ingress process of black seabream around baited pots and discussed how such findings can be useful to design and improve baited structures.

(H) Enhancing sustainability in snow crab fisheries: collaborative solutions for improving size selectivity, catch efficiency, and mitigating ghost fishing

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Snow crab is a commercially exploited species in cold-water areas in the Arctic Hemisphere using baited pots. Several sustainability challenges are common in the Arctic snow crab pot fisheries including low catch efficiency and unintended capture and mortality of undersized crab, as well as problems associated with lost gear such as continuous capture of snow crab by lost pots (ghost fishing) resulting in unintended mortality. Our research aims to increase research collaboration to develop technical modifications for improving sustainability in these fisheries by improving catch efficiency and reducing unintentional snow crab mortality. This poster describes several ongoing laboratory experiments to: (1) assess the performance of side entrances added to traditional snow crab pots to increase the catch efficiency of commercial crabs and the escapement of undersized individuals, and (2) assess the use of escape gaps in snow crab pots as a potential mechanism to improve size selectivity.

(I) Entanglement in fishing gear is one of the primary threats inhibiting the recovery of critically endangered North Atlantic right whales (NARWs)

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Low-breaking strength (LBS) modifications are approved Canada for voluntary use in Canada and have been implemented and used in parts of the United States. Implementation of these has the potential to alleviate the severity of entanglements. However, the low tension threshold of 1,700 lbsf is a safety and economic concern for deeper and heavier fisheries, such as the commercial snow crab fisheries in Atlantic Canada, where loads regularly exceed 1,700 lbs. Time-tension line cutters (TTLCs) are a double-threshold LBS device implemented in the endline above a trap that accounts for both time and tension using a hydraulic piston system. Time represents how long a maximum tension of 1,700 lbsf must be sustained on the TTLC before it will cut the endline, allowing harvesters to retrieve gear for long durations at heavy loads without the risk of gear loss. Our study aims to evaluate the effect of varying temperatures on cut time for TTLCâ€™s through a series of temperature controlled experiments that reflect the conditions of commercial fisheries in Atlantic Canada. These experiments represent the first time TTLCs are tested and assessed for implementation and will demonstrate whether TTLCs are a suitable LBS solution for harvesters If suitable, the use of TTLCs in fisheries could satisfy the voluntary LBS measure, without gear loss or impacts to harvester safety.

(J) Enhancing fisheries data collection through electronic monitoring and AI technology

Sander Delacauw[1]

[1] *ILVO*

Electronic monitoring is seen as a solution for addressing issues such as lack of observer coverage in terms of space and time, as well as challenges related to bycatch of sensitive species and adherence to policies. Currently, only a small fraction of the catch from Belgian beam trawl fisheries undergoes sampling for data collection. The objective is to rapidly expand this sampling using machine vision technology. To augment the existing observer program, ILVO has created a camera system capable of autonomously capturing images on vessels without requiring structural modifications for installation. This system, which can be easily implemented, has shown its ability to independently capture images. The next phase involves refining our recognition software to handle mixed catches, paving the way for its deployment in biological monitoring soon. Currently, this camera system can identify 19 different commercially valuable species with 97.6% accuracy. Future efforts will focus on expanding species recognition to include non-target species, especially Endangered, Threatened, and Protected (ETP) species, potentially through synthetic data generation. Furthermore, ILVO is researching the development and recommendation of AI-supported tools to provide stakeholders with data on catch volumes, compositions, and the fishing environment. The aim is to fully utilize technologies like electronic and genetic monitoring, along with AI-based species recognition via computer vision, to monitor discards and improve overall fisheries management. However, it's essential to acknowledge that technologies alone are insufficient. The integration of computer vision models, various data sources, and stakeholder needs and acceptance is crucial. Innovative monitoring, such as electronic monitoring, will also aid in developing prevention tools, like species distribution models. These efforts, represented by projects like VISIM, EveryFish, Marine Beacon, OptiFish, and CIBBRiNA, signify a significant advancement in fisheries management. By using advanced camera systems and machine learning, we can improve sustainability, mitigate bycatch, and contribute to the preservation of marine ecosystems.

(K) Can pots be an alternative fishing gear to gillnets? A Mediterranean case study

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Mediterranean small-scale coastal fisheries often employ gillnets, a widely used gear worldwide. The disadvantages of gillnets in this fishery include high bycatch levels of unwanted species and consequent discards. Furthermore, gillnet depredation by bottlenose dolphin (*Tursiops truncatus*) reduces commercial catches and damages the gear, often resulting in considerable economic loss. Alternative, more sustainable and profitable fishing methods are being tested. This study investigated whether pots can ensure the sustainable harvest of mantis shrimp (Squilla mantis), a major target demersal species in terms of landings, in the Adriatic small-scale fishery and possibly replace traditional gillnets. A multidisciplinary approach was adopted to investigate the catch efficiency, biological impact and socio-economic effects of the two fishing methods in catching S. mantis. For the first time in this area, we also determined gillnet depredation using Passive Acoustic Monitoring technology. We found different species compositions in gillnet and pot catches. Gillnets yielded a greater amount of discards of species of no commercial value, whereas pots caught a greater amount of mantis shrimp. Finally, profit analysis indicated that the pot fishery has the potential to increase profit for the commercial fishing industry. This study suggests that pots provide a more sustainable fishing method both in terms of revenue and of environmental impact, while also reducing conflict opportunities between fishers and dolphins.

(L) Enhancing durability and efficiency of purse seine: a study on variation in gear component strength and innovative design concept

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Purse seine fishing holds a significant place in Indian fisheries, by contributing the major share of pelagic fish landings in the country amounting to 1.98 million tonnes per annum (57% of the marine landings). In India, the purse seine fishery comprises of large, mechanised fishing units operated by the industrial sector and the smaller units operated by the traditional sector. The small purse seines popularly known as ring seines were introduced by ICAR-Central Institute of Fisheries Technology, Cochin in 1985 to empower the traditional fishers against the increasing exploitation of the pelagic resources resulting in the sidelining of the traditional sector. Ever since, the gear has become immensely popular throughout the entire coast of India and has grown in dimensions. This gear made of polyamide muti-filament typically utilizes one to five tonnes of webbing per unit and has a life of only two to three years. Nevertheless, the different components of the gear necessitate frequent replacement due to wear and tear before the end-of-life of the gear.

This study aims to identify and analyse variations in durability across distinct gear components and suggest suitable options for increasing the life of gear. Webbing panels were exposed to

natural marine weather conditions and simulated conditions (in accelerated weathering equipment) and residual strength of webbings estimated as per standard procedures (ISO 1806:2002). Besides, to study the strength retention in webbing after fishing operations, samples were collected from different locations of the gear every 100 m through the length and every 10 m through depth of the gear at periodic time intervals. Break load studies of ring seine sections shows that the sections with least strength retention are the areas adjacent to the bunt followed by front panel, bottom panel, top panel and end panel of netting. These areas showed unsuitability for use after 10 months of operation ie. 50% reduction in breaking strength, which is considered unserviceable as per Brandt (1959). Uneven durability poses significant challenges to fishers, as total replacement of the gear can result in substantial financial losses. Information about the durability across different segments of the gear, a concept for design of a ring seine with new generation material is proposed with materials like ultra-high molecular weight poly ethylene (UHMWPE), bite resistant polyethylene etc. The theoretical weight of the proposed model is 45 % lesser sinking speed is found to be 62.6 % higher and carbon footprint 60.43% lesser than the conventional gear. Durability of the new gear is estimated to be 2-3 times more than the conventional gear.

(M) Measuring weak breaking strength gear modifications before and after use in Atlantic Canadian fixed-gear fisheries

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Fisheries and Oceans Canada (DFO) is promoting the voluntary adoption of low breaking strength gear modifications in fixed-gear fisheries in Atlantic Canada in an effort to alleviate entanglement severity for the critically endangered North Atlantic right whale. However, DFO is not approving or regulating how these gear modifications are implemented. Our study aimed to identify low breaking strength solutions that would meet established US standards for low breaking strength gear (i.e., 1700 lbf + 10%) and to evaluate their change in breaking strength following use in Canadian commercial fisheries. Our methods were informed by international and North American standards for testing fiber rope, and by testing protocols from the Northeast Fisheries Science Center, which currently approves gear modifications for US fisheries. Control samples consisted of 20 types of sleeves, links, rope, and other contrivances marketed as low breaking strength gear modifications or as having a load threshold of 1700 lbf or less. These samples were tested in new condition to determine if they meet this standard based on their average breaking strength. Of those 20 controls, 10 types were also tested after use in simulated fishing trials (≤ 13 hauls) and 5 types after use by harvesters for one fishing season (50-60 hauls). When new, 7 of these 20 types had breaking strengths above 1700 lbf + 10% (i.e., 65% passing rate). Notably, the breaking strengths of the modifications that were tested following use were all reduced, many to well-below safe working load limits. The next step of this study is to evaluate the use of knots and splices as a low breaking strength solution for inshore fisheries. These findings have implications for the implementation of weak breaking strength gear modifications in Atlantic Canadian fisheries, specifically regarding their safe-use and seasonal replacement rates.

(O) Underwater observation plays a crucial role in fisheries technology, where the introduction of low-cost action cameras has significantly enhanced this aspect

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Action cameras have found diverse applications in fisheries science, from recording animal behavior in and around fishing gear to evaluating gear performance and modifications. However, two primary challenges have traditionally been faced: limited battery life and constrained viewing angles. By combining action cameras with external batteries, extended running times could be achieved allowing for recordings of long fishing activities like extended trawl hauls or long soak times in passive gears. However, the issue of the limited angle of view remained: In case a camera was not mounted properly, i.e. the angle of view did not fit to what was intended to be recorded, recordings of one fishing activity might have to be discarded and redone. While the introduction of panoramic cameras addressed the issue of limited viewing angles with their often up to 360Â°recording capabilities, they lacked options for extending battery life. In this study, we introduce a novel approach by combining a 360Â° camera with an external battery, enabling recording sessions up to 42 hours. As a practical application, we demonstrate the utility of this setup in investigating fish and crustacean behavior in pots but also animal behavior and habitat use around reef structures. This advancement not only opens doors to prolonged underwater observation, overcoming previous limitations and offering new insights into fisheries research and management, but also enhances the viewing experience through immersive virtual reality (VR) goggles. By utilizing VR technology, viewers can dive deeper into the recorded content, experiencing a heightened level of engagement and understanding of what is happening under the surface.

(P) Failures, no effects and lessons learned: an overview of unwanted results

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The way scientists communicate their work is by showing the successes, great results and astonishing data. Behind the fabulous presentations lies, more often than not, a long winding road of dead ends, frustration and hours of fruitless effort. Based on our own experiences and experiments in fisheries research, we want to bring a presentation in which we show not our greatest successes, but our failures, unwanted results and what we learned from it. By showing that, other scientists can benefit from our mistakes and not repeat experiments with bad results, saving time and money. We hope that giving a presentation such as this one can spark our community to start sharing “failure” information on a regular basis, which can only improve the research in our field.

(Q) Fish and click: how participatory science help to describe the distribution of lost fishing gear

Marie Morfin[1], Fabien Morandeau[1], Sonia Méhault[1] & Dorothée Kopp[1]

[1] IFREMER, Fishing Gear Technology and Biology Laboratory

Plastic pollution caused by fishing gear lost at sea is a major environmental problem since they remain for several hundred years in seawater, impacting marine life. Fishing gear accounts for almost a third of marine litter and are targeted by the recent European Directive on the reduction

of the impact of plastics on the environment. In this context, a website and mobile application were developed under the participatory project “Fish & Click” to report lost fishing gears both at sea or on the shore in the English Channel area. These tools are dedicated to a wide public including divers, fishermen, boaters, on-board observers, naturalist associations, walkers. 2944 reports were recorded from May 2020 to June 2022 and 83% were associated to pictures. All the reports were checked and corrected, if necessary (e.g. location, wrong gear categories or quantities), resulting in 2295 validated reports (90%). Fishing gears are well classified by citizens at 88% with most of the misclassifications for the categories ‘other material’ and whelk/shrimps/fish traps. At least 475 citizens participated with 5% of them being regular observers (>15 reports). So far, the database collected allow to inventory and map lost fishing gear by category. Most of the reports were done at the shore (83%) where all categories were detected but with spatial disparities. More nets, ropes and lines are found in Bay of Biscay, whereas other materials are more reported in the English Channel. At sea, 65% of the reports are due to scientific surveys, divers being the second source of information. Traps are reported exclusively in coastal seas whereas nets are found offshore. Results from this project will help to guide research on biodegradable fishing gear and to propose solutions for the management of lost gear.

5 TOPIC Group: The use of indicators to describe and compare the performance of fishing gears (TG Indicators)

Conveners:

- Valentina Melli (Denmark), vmel@aqua.dtu.dk (Physical)
- Jure Brčić (Kroatia), jure.brcic@unist.hr (Online)
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- Jordan Feekings (Denmark), jpfe@aqua.dtu.dk (Online)
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5.1 Introduction

An ICES- FAO WGFTFB topic group on Indicators (TG Indicators) was formed to gather information on indicators used by fishing gear technologists and experts outside the field.

The opening session of the TG Indicators aimed at establishing a network of scientists challenged by the need to summarize the scientific information needed to compare fishing gears and communicate it to stakeholders. The idea for this year was to clarify the definition of indicators in relation to fishing gears, explore their potential and define a strategy to collect literature regarding their use within the field.

5.2 Terms of Reference

- Review and describe available indicators that enable comparison within and across gear types, including defining their purpose and terminology.
- Identify the need for additional indicators, for example to evaluate sustainability according to its three pillars (ecological, economic and social).
- Find data sources (e.g. population structure for target, bycatch and discards) and potential synergies with other fields (e.g. fisheries management, social sciences, fisheries economics).
- Discuss and describe the use of single and combined indicators as decision-making tools for the stakeholders (fishermen, scientists and managers).
- Identify reference points (thresholds) to support the fishery management decision-making process.
- Explore visualization and communication methods to convey both single- and multi-species gear performance to different stakeholders.

5.3 Justification

Scientists across many fields are faced with the challenge of synthesizing and communicating in a simple and accessible way complex scientific information to stakeholders. The field of gear technologies is no exception, with an increasing number of studies now including indicators of gear performance in addition to the traditional approach of presenting the species-specific, length-based selective properties of the fishing gear. Such indicators, which can convey the consequences of adopting a gear design in a specific fishery, have shown great potential to support

stakeholders' decision-making processes. They are a versatile tool that can be used for multiple purposes. To evaluate the effectiveness of individual gear designs, either active or passive, in relation to sustainability objectives (environmental, economic and social). To compare multiple gear options within a fishery and identify optimal solutions in relation to both single- and multi-species catch objectives. To compare different gear types in terms of outputs (e.g. economic, ecological etc.).

The "Indicators" topic group will aim at reviewing existing tools and identifying further needs for simple, robust, and overarching gear performance indicators under the frame of sustainability. It will explore potential synergies with other fields, including fisheries management, ecosystem modelling, and fisheries economics to maximize the use of existing data. Moreover, it will frame the discussion on what are useful reference points for fishery management and carefully provide guidelines on how to use and visualize the indicators to support decision-making processes.

5.4 "Indicator" Topic Group Meeting 2024

5.4.1 Year 1 in brief and Work plan for year 2

In 2023, we focused on defining what we, scientists working with fisheries, consider a Fishing Gears Indicator (FIGI). We also discussed the purpose of FIGI indicators, their strengths and weaknesses, and who are the key stakeholders' group that can make use of them.

Among all possible stakeholders we identified three key target groups, which were the focus of the work plan in 2024:
Fishers
Managers
Consumers

The TG session in 2024 took place on the 5th of June. Only in-loco participants (Table 5.1) were allowed to actively participate, but the session was streamed for online participants, following the overall format of WGFTFB2024.

Table 5.1: TG Indicators, list of participants 2024.

Name	Surname	Affiliation
Ludvig	Krag	DTU, Denmark
Zita	Bak Jensen	DTU, Denmark
Junita	Karlsen	DTU, Denmark
Tiago	Veiga-Malta	DTU, Denmark
Sonia	Mehault	Ifremer, France
Kerwin	Wellon	Mustad Autoline, Canada
Juan	Santos	Thünen Institute, Germany
Antonello	Sala	CNR, Italy
Nadine	Jacques	UiT, Norway
Daragh	Browne	BIM, Ireland

Hans	Mustad	Mustad Autoline, Norway
Silvana	Dans	National Scientific and Technical Research Council, Argentina
Ilmar	Brinkhof	UiT, Norway
Claude	Dykstra	International Pacific Halibut Commission
Allard	Van Mens	WUR, The Netherlands
Chris	Kerry	University of Exeter, UK
Jasmine	Somerville	University of Stirling, UK
Tom	Rossiter	SafetyNet Technologies, UK
Pete	Brown	Marine Institute, Canada
Noëlle	Yochum	Trident Seafoods, USA
Colin	Frank	Marine Institute, Canada
Katherine	Yahnke	Alaska Pacific University, USA
David	Gauld	University of Massachusetts, USA
Lancelot	Blondeel	ILVO, Belgium
Damian	Moran	NZ Institute of Plant & Food Research, New Zealand
Edward	Schram	WUR, The Netherlands

Lesson learnt: there was extremely low overlap between TG participants in India (FAO hosted meeting) and in Canada. In hindsight, we should have requested participants to review year 1 report or allocate more time to refresh the key insights/discussion points (albeit at the risk of replicating work rather than advancing it).

The participants were split into three groups, based on interest and background, and asked to reflect on the following questions from the perspective of one of the three target stakeholders' groups:

- What information is desirable and for which purpose?
- At what scale is that information needed? (E.g. fishing trip, haul, vessel, season, fishery)
- What technology is needed to collect and transfer that information?
- How can the information be used as a decision tool?

5.4.2 Summary of discussions

5.4.2.1 The Fishers

The group of participants that chose to reflect on the Fisher's perspective identified two key sub-groups of interest, with different needs and access to technologies: Large-scale fisheries and Small-scale fisheries.

Figure 5.1: The Fishers group, ready to present their insights.

Large-scale fisheries are expected to focus on **economy-based indicators** such as **catch per unit fuel (CPUF)**, aiming to optimize operational efficiency and reduce costs. For this, they require real-time, **haul-level data** on factors like catch rates, bycatch, and fuel consumption to make immediate adjustments and maximize profitability. While large-scale fisheries already have access to advanced technologies onboard (e.g., sonar, fish finders, electronic logbooks), they need improved **data aggregation tools** to compile and analyse information effectively. Technologies like **AI**, **machine learning**, and **satellite-based predictive tools** could further enhance decision-making, allowing fishers to identify productive areas and seasons, minimize fuel usage, and adapt operations dynamically. **Automated gear monitoring** and **remote control** could also help improve selectivity and reduce environmental impact.

Small-scale fisheries, on the other hand, are likely to prioritize **social-based indicators** such as **recruitment**, **economic well-being**, and **gear usage** at the **fleet level**, with data typically collected on a **yearly basis** through surveys and community-led initiatives. The focus for these fisheries is often on sustaining local livelihoods, supporting fishing communities, and exploring alternative, more profitable opportunities when needed. Indicators of interest may relate especially to **diversification**, helping small-scale fishers explore new income streams (e.g., emerging species, access to restricted area) when data suggests their fishery may no longer be economically viable or ecologically acceptable (e.g. due to interactions with ETP species). **Low-cost technology** solutions, such as **mobile apps** for data collection and **blockchain** for product traceability, could be key in helping small-scale fishers manage their fisheries more effectively.

5.4.2.2 The Managers

The group of participants that chose to reflect on the Managers' perspective recognized their need to combine a great variety of information, typically simplified and condensed to facilitate decision-making processes. The group stressed that, for **Managers**, indicators are crucial for assessing the state of fisheries and guiding decisions on changes in **legislation** and **technical gear regulations,** as well as providing a **common language** to communicate with other stakeholders, such as fishers, consumers, and NGOs.

Figure 5.2: The Managers group, deep in discussion.

Purpose: Indicators help track compliance, ecological sustainability, and operational performance. They assist in determining whether new fishing technologies or policy changes are needed and in evaluating fisheries' impact on ecosystems.

Key Information Needs

1. **Catch Performance Indicators**: Baselines, changes, and comparisons in catch data.
2. **Discard Ratio**: Proportion of bycatch or discarded species.
3. **Proportion Above/Below MCRS/MLS**: Tracking size compliance.
4. **Multi-Species Indicators**: For mixed-species fisheries, assessing choke species and sustainability.
5. **ETP species**: Monitoring interactions with vulnerable species.
6. **Catch Welfare and Survival Indicators**: Post-release survival and fish welfare conditions.
7. **Ecological Indicators**: Tracking impacts on sensitive habitats, bottom impact, drag, energy use, and carbon efficiency.

Scale. Data is needed at various levels:

- **Gear Level**: Assessing how different gear impact species and ecosystems.
- **Species and Area Level**: Understanding species-specific impacts and geographical trends.
- **Socio-Ecological Level**: Economic and social impacts, including costs related to time, safety, and return on investment for new gear.

Timescale: Information should account for **seasonal variations** to align fisheries management with stock fluctuations and environmental conditions.

Technology for Data Collection: A **multi-disciplinary approach** is required, involving fishing gear technologists, fish behavior specialists, population dynamics experts, economists, and ecologists. This approach enables the collection of comprehensive data through **catch and landings monitoring systems**, **VMS (Vessel Monitoring Systems)**, and electronic monitoring tools.

Technology for Data Transfer: Managers need tools like the **INSER R package** (INSER : INdicateurs de SElectivité en Routine developed by Ifremer, France) or the **Shiny apps** (developed by DTU Aqua, Denmark) to compile and analyze data for informed decision-making. These technologies should simplify data interpretation for policy adjustments and communication with stakeholders.

5.4.2.3 The Consumers

The group that chose to reflect on the Consumers' use of FIGI, identified multiple sub-categories that seek different sustainability information tailored to their priorities. In particular, the group reflected that Consumers' interest in sustainable seafood varies if they are Retailers, high-income, and low-income consumers, or belong to Gen Z — with each sub-group seeking specific information and using different technologies to access it.

Figure 5.3: The Consumers group, role-playing one of the sub-categories.

Retailers need **sustainability certifications** (e.g., MSC, ASC) and **traceability** data to ensure seafood products meet standards and consumer expectations. They require data on **bycatch rates**, **carbon footprints**, and **gear types** to assess sustainability. **Blockchain** helps ensure traceability, while **digital labels** and **apps** help communicate this to consumers.

Gen Z Consumers prioritizes **environmental impact**, **carbon efficiency**, and **ethical sourcing**. They want information about gear impacts (e.g., bycatch, habitat destruction) and labour practices. **Mobile apps** and **blockchain** enable transparency, allowing them to make eco-conscious decisions and advocate for responsible consumption through social media.

High-Income Consumers seek **premium-quality** products **alongside sustainability**. They value **species-specific data, fishing methods,** and **gear information**. These consumers prefer detailed product histories via **QR codes** or **smart labels**, ensuring their purchases are environmentally responsible and ethically sourced.

Low-Income Consumers prioritize **affordability** but increasingly value basic **sustainability indicators**. They rely on simple **certification labels** like MSC to guide them toward responsible choices without increasing costs. **Clear, recognizable labels** on packaging are key to influencing these decisions.

5.4.3 Conclusions and FIGI relevant across stakeholder groups

Based on the reflections from **Fishers**, **Managers**, and **Consumers**, we identified several indicators that are potentially relevant across all three stakeholder groups because they address key concerns and priorities shared by each group.

- Bycatch and Discard Ratios

Fishers: Want to use efficient and selective gear to minimize bycatch and maximize target species catches to comply with regulations and save sorting time.
Managers: Need to monitor bycatch to ensure sustainability and minimize ecological damage, particularly for quota-regulated species and endangered species (ETPS).
Consumers: Especially **Gen Z** and **high-income** consumers care about the ethical and environmental impacts of bycatch. Reducing bycatch is often tied to certifications they value (e.g., MSC).

- Gear Impact on Biodiversity and Sensitive Habitats

Fishers: access to certain fishing area may be restricted based on the documented level of habitat and biodiversity impact for a given gear. Moreover, these are important parameters in sustainability assessment for certification purposes, thus affecting access to market.
Managers: Regulatory bodies may restrict or ban the use of certain gear types (e.g., dredges or bottom trawls) in protected areas to preserve sensitive marine ecosystems.
Consumers: Some consumers, especially high-income and environmentally conscious buyers, are interested in whether their seafood was caught in a way that minimizes habitat damage.

- Carbon efficiency

Fishers: Fuel costs are a major concern for large-scale fishers, especially those using drag-heavy gear like trawls. Reducing drag and energy use can improve fuel efficiency and profitability.
Managers: Monitoring the carbon footprint of fisheries is becoming more important in global efforts to mitigate climate change. Regulations may incentivize or mandate energy-efficient gear use.
Consumers: Gen Z and high-income consumers are increasingly concerned with the carbon footprint of the seafood they buy. Low-impact, energy-efficient fishing methods are more attractive.

- Socio-economic viability

Fishers: Small-scale fishers rely on data about the economic and social impact of fisheries to maintain community livelihoods and explore alternative opportunities.
Managers: Must consider the economic and social sustainability of fisheries when creating regulations to avoid displacing communities or causing undue economic harm.
Consumers: **Gen Z** and **low-income** consumers may be particularly concerned about ethical sourcing, ensuring that the seafood they buy supports fair labour practices and local communities.

Conclusion: although the purpose of the indicators, and the technologies used to collect the information needed, varies depending on the user group, there are several indicators that are relevant to all groups. However, the format and timescale of the information needed may differ. For example, bycatch and discard ratio can be quantified in weight (relevant to fishers and managers in relation to quota use), number of individuals (relevant for stock-assessment and welfare considerations), or percentage relative to target catch (relevant to management frameworks and ecolabelling schemes). It can also be summarized at the fleet and annual level, or at the vessel, fishing trip or even single gear deployment level. It is therefore important to gather information in a way that makes it possible to convert from one format to the other, depending on the target group.

5.4.4 Next steps

Ahead of the WGFTFB meeting in 2025:

- The conveners will select a few "convertible" indicators and launch a visualization contest to explore how the information could be best summarized and communicated to different stakeholders' groups (Open to all WGFTFB 2025 participants).

At WGFTFB 2025:

- Develop guidelines for data collection and processing to standardize Indicators formulation and align it with stakeholders' needs.
- Compile best visualization and communication practices and develop a standard layout for advice to management and fishers.

We look forward to seeing you!

6 TOPIC Group: Abandoned, lost or otherwise discarded fishing gear (TG ALDFG)

Conveners:

- Kelsey Richardson (Italy), Kelsey.Richardson@fao.org
- Haraldur Einarsson (Iceland), Haraldur.Einarsson@fao.org
- Roger Larsen (Norway), roger.larsen@uit.no
- (Amparo Perez Roda (Italy), Amparo.PerezRoda@fao.org, absent this year)

6.1 Introduction

As abandoned, lost, or otherwise discarded fishing gear (ALDFG) is a priority area for the FAO Fisheries and Aquaculture Division's fisheries technology and operations team (NFIFO), a topic group on this subject was proposed and accepted by the WGFTFB Chairpersons in 2023. The ALDFG Topic Group first convened at the WGFTFB23 meeting in India. During this meeting, a second topic group with similar terms was proposed. It was decided to merge these two groups for the second and third years, updating the Terms of Reference and Justification.

Several presentations were given at the 2023 meeting in India, followed by discussions in separate groups. The Terms of Reference and Justification and abstracts from the presentations are detailed in last year's report under the subchapter for this Topic Group.

Following last year's meeting, the Terms of Reference were reviewed, simplified, and broadened. The Justification was also updated, and an additional convener, Roger Larsen, joined the group. The revised Terms of Reference and Justification are provided below.

The topic group aims to gather state-of-the-art knowledge about ALDFG concerning fishing technology and fish behaviour and provide recommendations for further research. The group seeks to collect facts and propose direct measures to counter ALDFG in global fisheries. Given the expertise of WGFTFB participants, the particular focus was on examining fishing gear designs and modifications that aim to prevent, reduce, and mitigate the impacts of ALDFG.

6.2 Terms of reference

- Review and summarize current and past work to redesign and modify gears to reduce ghostfishing.
- Review and summarize current and past work to redesign and modify gears to increase the overall circularity of gears and the potential for repurposing and recycling.
- Investigate and summarize gear marking technologies.
- Develop a guide that outlines essential safety requirements to prevent a loss of fishing gear.
- Seek synergies with the Indicators TG around identifying and developing ALDFG-related indicators that can be used to guide the analysis of the data collected from the FAO Global ALDFG surveys. The indicators should be designed to meaningfully inform fisheries management policies and interventions designed to prevent and reduce ALDFG.

6.3 Justification

Abandoned, lost or otherwise discarded fishing gear (ALDFG) is a source of sea-based marine plastic pollution with a wide range of environmental and socioeconomic impacts. Some of these impacts include: wildlife entanglement in and ingestion of ALDFG, production of macro and microplastics, release of toxins, ghostfishing (the continued catch of target and non-target species after gear loss), fouling of benthic habitats, transport of invasive species, hazards to navigation and safety at sea, and economic costs and losses to fishers from losses of gear and associated catch. Education and technical guidelines, as well as gear modifications and changes in gear designs, can decrease the potential for gear abandonment, loss, and discard, as well as ghostfishing, and can support gear marking and tracking technologies. Gear modifications and changes in gear design can also enable better circularity of gears and can enable gear repurposing and recycling efforts.

This topic group will review, discuss and investigate gear modifications and designs that aim to prevent and reduce ghostfishing from ALDFG, enable gear stewardship through the inclusion of gear marking and tracking technologies, and support the responsible discard of recovered ALDFG and other end-of-life fishing gear (EOLFG). Synergies will also be sought with the Indicators TG to identify gear indicators for ALDFG that can inform fishers/administrators on different aspects of fishing gear that contribute to ALDFG prevention and reduction, minimisation of ghostfishing, the potential for gear marking and tracking, and circularity of gear designs.

6.4 Group discussions/Progress

At this year's meeting, the topic group had no presentations. Instead, we dedicated more focus and time to each term of reference. With 27 attendees in the topic group, we had an excellent turnout that significantly boosted our efforts. After introducing the work, subgroups were formed, each assigned one term of reference. The goal for each group was to collect information addressing the following points:

- **Introduction:** Explaining the importance of focusing on that ToR.
- **State of the Art:** Reviewing current and past work known to the group.
- **Current Work:** Identifying ongoing innovations or developments.
- **Recommendations:** Guiding stakeholders, scientists, and management.

Each subgroup had a leader responsible for follow-up, post-meeting tasks, and planning work for the following year. Following are brief descriptions of what came out of each sub-group of the ALDFG ToRs:

6.4.1 Guide to prevent loss

The fourth sub-group, led by Roger Larsen, with four attendees, discussed the ToR: *"Develop a guide that outlines essential safety requirements to prevent a loss of fishing gear"*. This was the first meeting of this ToR, and four attendees worked on this task. We started by discussing the justification of the ToR: There is a consensus about the need for global awareness and responsibility for sustainably managing marine and freshwater (i.e., inland, lake) environments.

Fisheries and aquaculture industries aim at avoiding loss of gears and gear components, reducing plastic pollution and potential ghost fishing. Fishing gear losses also imply other consequences for the industry, such as possible injuries (if, for example, a buoy-line breaks) and economic losses due to, for example, costs of the lost fishing gear and catches, and time and effort spent in searching for lost gear.

The group discussed whether the focus of this ToR should be on all fishing gear types or a selection of gears. The group decided to focus primarily on passive gears like gillnets, driftnets, trammel nets, pots, traps, fykes/weirs, hook and lines, FAD's and others since they are more easily lost than towed/mobile fishing gears (e.g., bottom trawls, beam trawls, pelagic trawls, demersal seines, purse seines).

The group acknowledges the competence of fishermen. Gear losses are accidental and causes negative consequences, i.e., loss of catch and costs by replacing lost gears. However, the gear can also be abandoned and otherwise discarded because of intended actions. Reasons why fishing gears and gear components are lost can be:

- Lack of competence/knowledge about forces during deployment and retrieval of fishing gears.
- Breakage of buoy-lines due to tensions (stuck at the seabed in debris, stones, entanglement with other gears etc.).
- Gear entanglements/collisions (e.g., bottom trawling vs gillnetting or pot fisheries).
- Reduction of fiber and rope strength from usage, abrasion, UV-radiation, storage conditions, etc. depends on material type and production form, dimensions, breaking force, and age.
- Unfavourable weather conditions and rough waters can lead to broken anchoring, accidental breakage of buoy-lines, loss due to insufficient attachment of markers (i.e., highflyers, buoys, floats), loss of sections from a fleet of gears (e.g., gillnets or pots).

The group aims to prepare a simple guide (including text, drawings, and tables) to enhance the awareness of factors leading to the loss of fishing gear. Knowledge about forces acting on fishing gears and factors leading to reduced breaking strength and gear losses should be described in simple terms. The guide shall refer to information from fishing gear producers and suppliers. The guide shall pinpoint consequences for the environment from ALDFG (such as plastic pollution and ghost fishing) and negative consumer perceptions and provide requirements for avoiding ALDFG.

The summary of a guide that outlines essential safety requirements to prevent fishing gear losses in commercial and recreational fisheries should cover the following points:

1) Examine and describe internal factors (fishermen's competence) and external factors (weather, other physical factors).
2) Review of gear handling practices. We suggest focusing on passive gears, i.e., all types of gillnets, hook and lines (longlines) and pots/traps, aiming at understanding why and how fishing gears are lost.
3) Information from current work and existing guidelines based on a review of existing literature, including reports, articles, FAO manuals. These might be supplemented with information from questionnaires if necessary.

6.4.2 Circular economy

The second Sub-group was kindly led by Georg Hanney, and the task was to collect information for the ToR: "*Review and summarize current and past work to redesign and modify gears to increase the overall circularity of gears and the potential for repurposing and recycling.*"

6.4.3 Fishing gear marking

The third sub-group, led by Haraldur Einarsson, focused on the ToR: "*Investigate and summarise gear marking technologies*". This group comprised five attendees. They acknowledged that

mandatory worldwide fishing gear marking is likely to be approved by 2028. However, most nations currently lack a standardised methodology for registering or marking fishing gear.

There is a need for greater awareness among policymakers, managers, and scientists, who will provide instructions to stakeholders on implementing this new practice. The group agreed that a clear distinction must be made between three main types of gear marking:

- Virtual Marking: Where the location of fishing gear is marked on electronic maps visible to users of the same system.
- Surface Marking: Applicable to local fishing gear such as nets and traps.
- Traceable Markings: Markings on fishing gear that are traceable to the owner if lost.

The group emphasised that the primary focus should be on traceable markings, as this aligns with upcoming international commitments. Tags such as RFID were identified as very promising, provided that compliant records are maintained. Additionally, easily readable tags are essential. Various other matters were discussed and will be developed into text for review, including several recommendations that will be reviewed next year.**Guide to prevent loss**

The fourth sub-group, led by Roger Larsen, with four attendees, discussed the ToR: "*Develop a guide that outlines essential safety requirements to prevent a loss of fishing gear*".

6.4.4 Creating indicators for ALDFG

Finally, the last ToR about creating indicators for ALDFG "*Seek synergies with the Indicators TG around identifying and developing ALDFG-related indicators that can be used to guide the analysis of the data collected from the FAO Global ALDFG surveys. The indicators should be designed to meaningfully inform fisheries management policies and interventions designed to prevent and reduce ALDFG*". There was not any sub-group created for this ToR; however, it was discussed to be looked at from each other sub-group to address this point. Kristine Cerbule kindly volunteered to keep track of this ToR and continue to shape it for discussion next year.

All groups successfully addressed most points and discussed their respective topics. The text from their work will be further developed. Next year's efforts will focus on reviewing this text and thoroughly examining the recommendations provided by each group. The aim is to have a fully written report from the topic group soon after the next WGFTFB annual meeting.

6.5 Topic Group Participants

The topic group meeting was held in person, with 27 participants from 11 countries. The highest number of participants came from Canada or 9 in total.

Name	Surname	Affiliation / Institution	Country
Aida	Campos	IPMA	Portugal
Anchares	Via Murrald	Osac (Pingme	Norway
Chiyo	Takahashi	Graduate School of Fisheries and Environmental Sciences	Japan
Daniel	Stepputtis	Thuenen Institute of Baltic Sea Fisheries	Germany
Derek	Curtis	NL Dept of Fisheries Forestry and Agriculture	Canada
Drake	Ssempijja	University of Massachusetts, Dartmouth	USA
Elsa	Cuende	AZTI	Spain
Genevieve	Peck	Memorial University	Canada
Georg	Haney	Hampidjan Group	Iceland
Haraldur	Einarsson	MFRI / FAO	Iceland
Jon	Lansley	FAO	Italy
Kelly	Moret	Hampiðjan Canada	Canada
Kelsey	Richardson	Food and Agriculture Organization of the United Nations	Italy
Khanh	Nguyen	Fisheries and Oceans Canada	Canada
Kirklen	Johnson	Canadian Wildlife Federation	Canada
Kopp	Dorothée	Ifremer	France
Kristine	Cerbule	UiT The Arctic University of Norway	Norway
Larsen	Roger B.	UiT the Arctic University of Norway	Norway
Mark	Santos	Memorial University	Canada
Matthew	McHugh	Ireland's Seafood development Agency (BIM)	Ireland
Pingguo	He	University of Massachusetts Dartmouth	USA
Sara	Alvarez Berzosa	Thuenen Institute of Baltic Sea Fisheries	Germany
Sidney	Andrade	Fisheries and Marine Institute of Memorial University of Newfoundland	Canada
Tomas	Araya-Schmidt	Memorial University	Canada
Truong	Nguyen	Fisheries and Oceans Canada	Canada
Vang	Nguyen	Fisheries and Marine Institute of Memorial University of Newfoundland	Canada
Yoshiki	Matsushita	Nagasaki University	Japan

7 TOPIC Group: Operational and technical constraints of fishing gears to support coexistence with off-shore wind and open-ocean aquaculture (TG Multi-use)

Conveners:

- Esther Savina (Denmark), esav@aqua.dtu.dk
- Jasper van Vlasselaer (Belgium), jasper.vanvlasselaer@ilvo.vlaanderen.be
- Mattias van Opstal (Belgium), mattias.vanopstal@ilvo.vlaanderen.be
- Thomas Noack (Germany), thomas.noack@thuenen.de

7.1 Introduction

We believe that a science-based approach to better understand the operational and technical constraints from the offshore wind, open-ocean aquaculture and fishing industries can facilitate co-existence. Focus will be given to discuss how one can design wind and aquaculture projects that guarantee safe conditions of work for the fishers given the specificities of their traditional gears and operational tactics with respect to e.g., alignment, space between machines/cages or cable burial, as well as the potential for innovative fishing capture techniques to accommodate for other users.

7.2 Terms of Reference

- Better understanding of the constraints from the different stakeholders by inviting key-note speakers from the various industries (e.g., wind, aquaculture, fisheries, insurance, collision risk)
- Share experiences from the different countries on multi-use of marine areas including presentations of findings from ongoing research projects
- Identify knowledge gaps in our current understanding of fishing gear operations, e.g., penetration depth or space required to manoeuvre, to support scientific documentation of the fisheries constraints with respect to multi-use
- Discuss the potential for innovative fishing capture techniques to accommodate for other users (e.g. within offshore wind farms) incl. passive gears

7.3 Justification

With increased competition for space at sea, maritime multi-use is key to enhance the sustainable joint use of resources such as wind, capture of wild fish and fish farming. However, coexistence is not always straightforward, as each industry holds technical specificities required to provide economic viability and safe operation. The objective of the topic group is to develop scientific documentation that provides practical solutions, guidelines, and recommendations to support

the harmonious coexistence of all stakeholders, ensuring sustainable resource utilization and minimizing potential conflicts.

7.3.1 Presentations

This section summarises the presentations that were shared during the 2024 Multi-Use TG meeting and during the plenary session that focussed on Multi-Use. Notes taken during the discussions after both presentations of the TG meeting are also included.

7.3.1.1 Offshore Wind technologies for gear technologists - Keynote presentation during TG

Pierre Warlop

Natural Power France, 1 boulevard Salvador Allende 44100 Nantes, France, pierrew@naturalpower.com

Pierre entered the wind business in 2007 and has been working as technical director on several offshore wind projects (including some currently in construction and operation). Pierre is now managing director of the renewable energy consultancy and service provider Natural Power in France. He gave us an overview of the different technologies in use, the technical studies undertaken to decide on the choice of technologies and farm layout, as well as an overview of coexistence challenges and opportunities between the harbor development necessary for construction, operation and maintenance of the farm, and the fishing industry.

Summary - presentation

- Professional experience: Wind turbine manufacturer, OWF developer and operator (privately-owned), now independent consultancy for renewables only e.g. solar, wind, P2X. from initial planning to decommissioning (company based in UK, projects all over the world especially Europe and US/Canada, also owners of vessels and technologies such as lidars)
- Offshore renewables include wind (fixed and floating) but also wave and tidal
- Main objective with renewable offshore infrastructures: fight climate change
- Offshore pioneered in the North Sea, but shallow with sandy sediments which is quite unusual conditions compared to other parts of the world, limitations e.g. Africa due to grid capacity
- Shallow waters: bottom-fixed versus deep waters: floating, more expensive for now but huge potential (deeper waters + more and more competitive costs with e.g. 86.45 EUR per MW in first commercial tender for floating in France
- Where can we install: 3% of total European sea waters, main challenge for the wind industry: willingness to pay and therefore proper location, maritime spatial planning sometimes dependant on changing politics vs OWF long-term planning required between initial planning until operation
- Balance necessary between grid connection, distance to shore and spatial conflict
- Further offshore: wind resource should be adequate, larger projects and turbines with more distance to shore
- Balance between size, wind resource and nominal power of the turbine
- Water depth and soil characteristics drive the choice of foundations:

    - Bottom-fixed (monopile, tripod, jacket, gravity-based) up to 60-70m depth, cost is mainly on piling the monopile
    - Floating (several prototypes, still under development and not fully standardized yet incl. types of anchoring systems e.g. semi-submersible, Tension Leg Platform, Spar), cost is mainly on mooring
- CAPEX (investment)
    - Higher for floating than bottom-fixed
    - What drives the costs: water depth, met-ocean conditions and distance to shore (incl. installation vessel rate with very different process of transit and installation between bottom-fixed and floating)
- Overall, floating is less impactful but challenges the multi-use (catenary mooring) and ballast discharge
- TLP: less space but higher load and lines need redundancy (multiple lines)
- Usually, the wind industry will try to minimize cable length and position of the substation to reduce cost (the "spider" configuration) but agreed configuration can account for e.g. fishing corridors instead (at a higher price but with acceptance)
- In floating cases, optimized layout is more challenging, as a principle there is exclusion zone and due to small project size for now fishers also prefer not to enter (examples considered here: Kincardine, EolMed, Provence Grand Large)
- Colocation with aquaculture: more costly day to day operations for aquaculture if OWF is far from shore (>10kms) and low investment capacity, but long-term surveys can support further development (case specific), collocation is easier to implement

Summary - Q&A

Could OWF achieve the biodiversity requirements by developing multi-use?
Yes, especially in e.g. North Sea with many projects, acceptability is key and may need additional externalities from the developers.

Do OWF monitor fishing activity within the farm?
Yes, but sensitive information i.e. personal data and business confidentiality.

Relocation of boulders around the cables?
Yes, also small changes around the layout to reach agreement with stakeholders.

Lifetime difference between bottom fixed and floating?
Basic assumption, should be same as bottom-fixed and driven by the turbine lifespan: 20 years now, extending up to 25-30 years due to investment cost

Colocation rules?
Nothing is substantiated, safety for running OWF is different from other activities e.g. aquaculture, might be an interesting transfer of knowledge from e.g. fishing to OWF

7.3.1.2 Environmental aspects in OWF business - Keynote presentation during TG

Jon Christian Svendsen

National Institute of Aquatic Resources, Vejlsøvej 39, 8600 Silkeborg, Denmark, jos@aqua.dtu.dk

Jon is a senior researcher at the Technical University of Denmark working on potential for synergy in coastal areas to maintain marine biodiversity with application to offshore structures (oil and gas, wind farm) and artificial reefs. After providing background knowledge about the environmental effects and impacts of wind farms based on the long-term Danish return of experience (including decommissioning) and recent literature review, he will present the ongoing project WIN@sea that investigates the multi-use concept between offshore wind farms and food production tested at Scandinavia's largest wind farm Kriegers Flak.

Summary - presentation

- Oil and gas platforms, already present with likelihood to be decommissioned but it can also be reconstructed, and OWF
- Fish, and recreational and commercial fisheries with focus on cod (backbone in many fisheries)
- strong believer that multi-use is possible and can help recover stocks (sustainability)
- Life Cycle of offshore infrastructures
    - Exploration and planning, including surveying that can already have impact e.g. acoustics (5-10 years)
    - Construction e.g. piling the monopile into the seabed that is noisy and has implications for the marine life (1-2 years)
    - operation, disturbance from service vessels, vibrations and electro-magnetic fields around the cables (25-45 years) (depending on infrastructure and local conditions)
    - decommissioning (when the permit runs out) OSPAR legislation in Europe has strict rules that the infrastructures should be removed, in US part can be left to keep the attached hard substrate flora and fauna (1 year)
        - Example of OWF decommissioned and removed on sandy seabed at water depth 2-10m (shallow) at Vindeby 1991-2017 for cost > 2M EUR
- Are OWF functioning as artificial reefs?
    - Glarou et al.: Scour protection of monopile providing habitat and fauna benefit from cavities
- Research approaches:
    - CPUE by distance to platform
    - fish tracking using acoustic transmitters and receivers: if cod is spawning in OWF it could be producing eggs in pelagic phase and then spread and settle in other areas e.g. coastal areas with depleted stocks ("fish hub" to larger areas), this is the assumption but there is no documentation yet (research ongoing)
    - when no permit to catch the fish e.g. Baltic Sea: pole and wing with camera standing on the seabed and lowered/retrieved with rot and line, recordings of 10 min as sampling unit
- Win@sea project
    - Baltic Sea, construction during COVID, now in operation (2021)

- 132 km2, 72 turbines each 188 m height and 170 km of cable
- mostly sand + glacial till (harder) with big rocks presents so considered a natural reef
- idea tested: turbines and foundations, mussels (settling naturally) + macroalgae on lines as food production in addition to the reef effect (incl. nutrient absorption to mitigate eutrophication)
- 50 video sequences for each treatment: sand, scour protection and natural reef

Summary - Q&A

- Minimal fraction added as hard structure is limited, though in some areas the reefs have been removed by extraction and scour though limited may help
- Is it a good thing to add a new structure on natural habitat: depends on type of bottom, no for sand species but beneficial for reefs
- Danish fishers (passive gears) can fish but do not: marine environment is depleted in many cases, OWF will not dramatically change the marine environment if it is already depleted, but no investigation here on whether it is profitable or not (though studies conclude that there are more fish around the OWF) but electro-magnetic fields may affect negatively as well and deserve further focus
- Distance to fish around the scour protection, and what technique could be used? Pots are being considered on scour protection (but not Jon's area of expertise), restrictions are local
- Brackish waters in relation to mussel and algae growth (poor due to low salinity): planned in another area (Kattegat) where salinity is higher, here a bit of a mismatch (or a worst-case scenario), production planned for human consumption providing they are large enough
- Foundations design for OWF constraints without special consideration on biological or fisheries perspective
- Most results for now on monopiles, what about floating? Very low numbers of floating projects constructed, so we do not know. Most likely electro-magnetic field through the water column, of big interest in the future
- Seasonal variation in the fish distribution? In the US, there is a return of experience with spring and fall with good abundance but not in summer. In Dk, limitations in funding so only sampling in summer due to high costs going far offshore. ILVO also has observed differences due to migrations (and return to given mills).
- Behavior of larval cod attracted by low frequency of the turbine, what about predators in the pelagic phase? Definitely not straightforward, before larvae there are eggs which may be transported far away - a complicated issue, and we cannot track eggs or larvae in real life, but models show they can distribute far beyond the OWF. Maybe genetic analysis can demonstrate recovery on coastal populations.
- Underwater maintenance at the OWF: oil and gas remove the growth, but we do not think they do in OWF

- Permit to access OWF for sampling and research is much easier than oil and gas

7.3.1.3 Development of a spatiotemporal model to assess coexistence between fishing and offshore wind farms - Plenary session presentation

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BIM, Ireland

Globally, governments have committed to decrease reliance on fossil fuels and increase renewable energy generation. To date, Ireland has many offshore wind farm (OWF) applications in preplanning stages; 6 of these projects have been recently expedited by government to reach full commissioning by 2030. These developments will occupy marine space which is currently the source of Ireland's 1.26-billion-euro seafood sector. Research has broadly examined OWF impacts on ecology, socioeconomics, fisheries, etc., although comprehensive analysis and evidence of fishing activity occurring directly within operational OWF's sites is rare. This study aims to investigate European OWF footprints and frequency of fishing within their spatial extents to reveal farm infrastructure design factors which may be conducive to coexistence. The methodology utilizes open source and proprietary datasets, and robust spatiotemporal modelling techniques. The results will identify key barriers or enablers regarding coexistence. Implications and recommendations for Ireland's developing OWF industry & marine spatial planning process will be discussed.

7.3.1.4 Staying in your lane: Scaled images of mobile fishing gears in U.S. offshore wind arrays - Plenary session presentation

Mike Pol, mike@rosascience.org

ROSA, USA

Development of offshore wind may result in voluntary exclusion of fishing effort from within turbine arrays, particularly mobile gears. Offshore wind developers in the U.S. have attempted to provide adequate spacing for fishing to continue, but fishers for the most part say that safe operation of their gears requires greater distances than those provided. The size and scale of these inter-turbine distances as well as of the individual turbines is quite large: turbine heights can be 850 m from the surface of the water and inter-turbine distances can be 1.3-1.8 km. To aid discussion of gear-related issues related to access, scaled 2-dimensional drawings were presented of two different gear types: demersal otter trawls, scallop dredges, and hydraulic clam dredges. Sizes of gear and rigging were vetted with multiple fishing industry representatives. Drawings appear to show sufficient space for fishing, although fishing practitioners still indicate they will choose not to fish in these areas. Safety concerns go beyond physical space and also include relocations of boulders (potential gear hangs) and radar interference; however, some bottom trawl surveys are being conducted within arrays. Gear technologists should investigate and develop a better understanding of spatial use by mobile fishing gears and vessels both at the surface or at the bottom to attempt to provide deeper insight of their spatial needs.

7.3.2 Group discussions /Progress

The topic group met on 05.06.2024 from 11:15 to 17:00. After the introductory expert talks, the TG, its conveners, its content and its ToRs were presented. This introduction was followed by an advanced "Round the table" asking all participants for the status regarding wind farms in their countries, the combination of fisheries and windfarms, ongoing relevant projects. The outcome is summarised in a table that is shared between WGFTFB members. The document is made available on the sharepoint to be updated by all WGFTFB members at any time. Furthermore, participants were asked under that setup about their expectations of the topic group. The responses were rather similar between all contributors mainly being interested in seeing, learning and understanding, how the current situation is in other countries and what the future plans are. Additionally, many participants see the TG as a platform to network and exchange about the coexistence of offshore wind farms, fisheries and aquaculture.

7.3.3 Topic Group Participants

Of the total 26 TG participants (including conveners), 23 attended in person and three online, representing 13 countries.

Table 7.1: TG Multi-Use, list of participants.

Participant	Affiliation	Country	E-mail Address
Esther Savina	DTU	Denmark	esav@aqua.dtu.dk
Thomas Noack	Thünen	Germany	thomas.noack@thuenen.be
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Mattias Van Opstal	ILVO	Belgium	mattias.vanopstal@ilvo.vlaanderen.be
Barry O'Neill	DTU	Denmark	barone@aqua.dtu.dk
Sara Berzosa	Thünen	Germany	sara.berzosa@thuenen.de
Craig Rose	FishNext Research	USA	fishnextresearch@gmail.com
Dan Watson	SNTech	UK	dan@sntech.co.uk
Aaron Whitman	GMRI	USA	awhitman@gmri.org
Chris Rillahan	UMASSD	USA	crillahan@umassd.edu
Keith Haukowsky	UMASSD	USA	khaukowsky@umassd.edu
Lasse Rindahl	Mustad Autoline	Norway	lr@mustadautoline.com
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Steve Earys	FRDC	Australia	steve.earys@frdc.com.au
Mike Pol	ROSA	USA	mike@rosascience.org
Tom Catchpole	CEFAS	UK	thomas.catchpole@cefas.gov.uk
Henrik Lund	DFPO	Denmark	hl@dkfisk.dk

Robin Failletaz	Ifremer	France	robin.failletaz@ifremer.fr
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Heui-Chun An	National Fisheries Research and Development Institution	South Korea	anhc1@korea.kr
Michelle Cho	New England Aquarium	USA	mcho@neaq.org

8 Focus session: Instruments, technologies and AI for fishing technology and fish behaviour research

8.1 List of Conveners

This focus session was introduced and moderated by Daniel Stepputtis (Thünen Institute, Germany) and Pieke Molenaar (WMR, Netherlands).

8.2 Introduction

WGFTFB members use a wide range of instruments and technologies to collect data on gear performance and fish behaviour. Research groups use and/or develop innovative technologies that may be useful for other groups conducting similar research. This focus session was held in plenary to encourage discussions on common topics relevant to WGFTFB's work. This focus session provided a platform to share recent developments in technical solutions and AI used for fishing technology and fish behaviour research.

8.3 Terms of Reference

- Summarize current, past, and future work in relation to technological developments in instruments and technologies used for observing fishing technology and fish behaviour (FTFB) and collection of data.
- Discuss instruments and methods that are used to collect FTFB data on commercial fishing vessels, and their limitations.
- Identify synergies, developments and make recommendations on how to improve technologies used in FTFB research.

8.4 Justification

In fishing technology and fish behaviour research a wide range of technologies are used to collect data on gear performance, catch composition and species behaviour related to innovative fishing gear solutions. For example, for assessing trawl- and fish behaviour underwater camera systems are often used, in some circumstances specialized solutions to project camera systems, extend battery life or deployment at great depths are employed. Within WGFTFB, presentations in this focus session on those innovative solutions informed members what can assist with acquiring better data.

8.5 Focus Session meeting 2024

This Focus Session was facilitated by the conveners in plenary session on the afternoon of 06 June 2024.

During the introduction information on the interests and desired future technologies of WGFTFB members were collated using a Mentimeter online poll. The results of a short questionnaire, as provided in Figure 8.1, Figure 8.2, Figure 8.3 below, were presented and discussed.

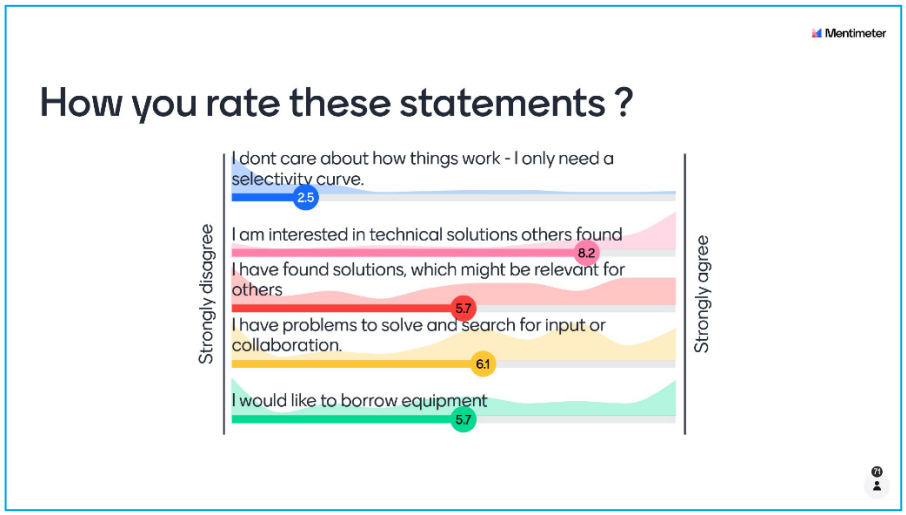

Figure 8.1: Focus Session questionnaire; Question "How you rate these statements?"; source: www.mentimeter.com

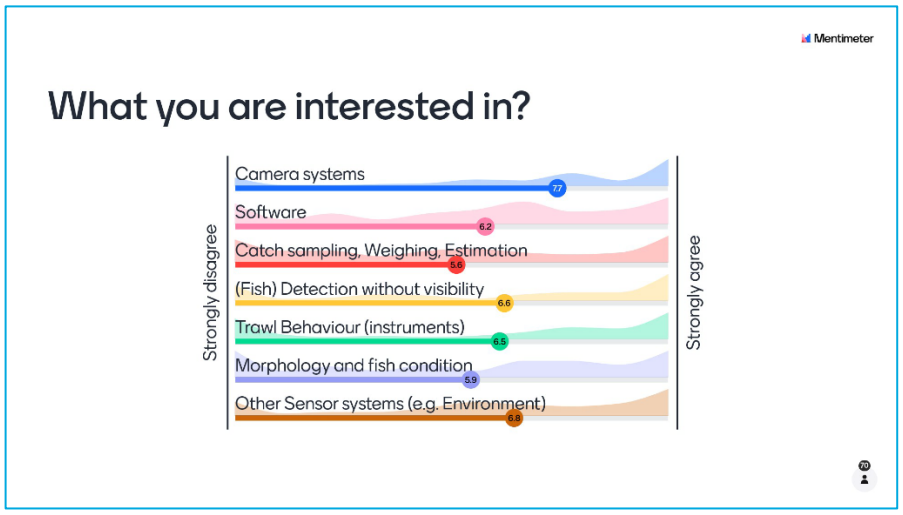

Figure 8.2: Focus Session questionnaire; Interest of WGFTFB members in sampling instruments during the focus session. ; Question "What are you interested in ?"; source: www.mentimeter.com

Figure 8.3: Focus Session questionnaire; Desired future technologies and interests of WGFTFB members during the focus session. ; Question "Which topics/technologies do you need ?"; source: www.mentimeter.com

8.6 Presentations

A range of interesting innovations including fish detection, catch monitoring, artificial intelligence, sensor systems or fish morphology measurement systems of relevance for the WGFTFB members were included in this focus session and sixteen presentations were delivered in plenum.

(50) Improving discard quantification on commercial fishing vessels. Discard valves, load cells and catch estimations

Allard van Mens [1]

[1] *Wageningen Marine Research*

We want measurements, not estimates!

The aim of this project was to test multiple technical solutions for accurate measurements of total catch and discard quantities onboard commercial beam trawl vessels, that are participating in gear technology trials and discards monitoring programs in the Dutch North Sea. For these programs, amounts of discards are usually calculated by subtracting landings (i.e. marketable fish) from the total catch (i.e. all fish caught in the net). The total catch is usually inferred through an estimation of the haul weight by the skipper and/or researchers (i.e. optical estimations). The composition of discards is rendered by taking a discard subsample, weighing it and sorting it to species level. These species are then individually measured for length and weighed collectively. This way, with a ratio of estimated discards weight to the discard subsample weight, the composition of all discards is estimated. This method has been criticized by stakeholders in the Dutch fishing industry and scientists alike for being imprecise due to the visual estimation of the total catch.

To investigate other, potentially more precise, catch and/or discard measurement methods a trial aboard a commercial fishing vessel was undertaken. During this trial the following measuring methods were considered: sea state compensated measurements of the total catch in a cod-end, 'traditional' visual catch estimations by fishermen and scientific observer, hopper fill combined with volume to weight conversions, conveyor belt rotations (in sorting area), collecting all

discards (which was used as a reference) and a discard valve with integrated sea state compensated scale. Also, a discards subsample basket was taken from every sampled haul. From the subsample a common and less frequent discard species (plaice and sole respectively) were selected and measured. The sample was raised to the total catch or total discards for every method. The results for both species for every method were then compared to the exact amount in the collected discards. From every sample taken the length of 50 plaice and sole was measured. These length frequencies were then raised by the subfactors resulting from every method and compared to 150 measured individuals in a completely sorted haul. The differences in length frequencies differed (in some cases by more than 150% for an individual length).

The discard valve appeared to be the most precise method, although the total amounts of discarded sole and plaice were consistently underestimated. The valve is still a prototype and will have to be improved to be able to process larger amounts and occasional large objects (larger fish, wood, stones, debris). This method was also relatively workable on board the vessel. The other methods had large uncertainties and performed worse than the discard valve. The further development of a functional tool for accurately measuring catch and discards on commercial vessels will be at the heart of future developments in monitoring and fishing techniques (e.g., Electronic monitoring).

(51) Reducing fishing impacts in marine ecosystems: modifications to set nets

Monika J. Szynaka[1], Pedro Rocha[1], Pedro Monteiro[1], Karim Erzini[1,2], Jorge M.S. Gonçalves[1,2], Aida Campos[1,3]

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Trammel nets and gillnets are used by many vessels of the Portuguese coastal multi-gear fleet, comprising around 500 vessels with LoA above 9 m. This type of gear is used to catch a variety of species, with impacts both on benthic populations and their habitats. Modifications to trammel nets (e.g. the "greca") were tested in many fisheries to reduce by-catch, but not commercially adopted given the observed reduction in commercial catches along with reductions in unwanted by-catch. In this study, modified trammel nets and gillnets, raised off the bottom through a system of ropes ('aranha', according to the local fishers) were tested in the cuttlefish (Sepia officinalis) and the hake (*Merluccius merluccius*) fisheries in a rocky bottom area, where by-catch of invertebrates, including sensitive habitat-forming species is high. A reduction in the capture of corals and sponges was attained when the modified nets were used, with non-significant changes in the capture of the target species. During the experiments, a video analysis assisted in accounting for all individuals of the habitat-forming species caught in high volumes that were overlooked in real time data collection onboard due to regular hauling procedures by commercial fishers. A net damage assessment was carried out, showing that the damaged area in standard nets triples that observed in modified nets. The financial impact of the use of the modified nets is discussed, along with the possibility of automating the video analysis, with a focus on quantifying the number of habitat-forming species as the individuals of various species are difficult to assess. Finally, the upcoming work within the framework of TramSel will be addressed. Opinions from fishers on the usefulness of a future implementation of the proposed changes were collected, offering a solution to be disseminated to the sector in the near future, within the scope of the TramSel project.

(52) Developing an intelligent discard chute with optical imaging and machine learning to revolutionize the electronic monitoring program for New England groundfish fishery

Pingguo He[1], Christopher Rillahan[1], Ming Shao[1], Rick Usher[2], Josh Wiersma[3] & Jeff Douglas[3]

[1] *University of Massachusetts Dartmouth, New Bedford, MA, USA*

[2] *Issac Davison and Peter Melanson, A.I.S. Inc.*

[3] *Integrated Monitoring Inc.*

This presentation reports the design and construction of an intelligent discard chute that incorporates optical imaging and machine learning to automatically detect species and measure sizes of fish that are being discarded through the chute. Images from the camera inside the chute are integrated to other video images from other deck cameras, and are streamed via satellite or cellular network, more recently via more affordable Star Link service, to the office for processing and auditing. Algorithms for video image analysis using artificial intelligence and machine learning are being developed to document species and measure size (length) of fish being discarded. This project is a collaborative effort among an electronic monitoring enterprise, an at-sea observer company, and fisheries researchers and an AI/ML expert, with an aim to incorporate new technologies in the field of fisheries monitoring to meet the increased fisheries monitoring requirement in New England and elsewhere in the world.

(53) Panoramic Perspectives and Extended Battery life: Advancing Underwater Observation in Fisheries technology

Peter Ljungberg[1], Andreas Sundelöf[1], Sara Berzosa[2], Andreas Hermann[2], Andrea Milanelli[2], Daniel Stepputtis[2], Hampus Södergren[3] & Thomas Noack[2]

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[3] *Hanö Torskrev, Bivägen 2, 294 36 Sölvesborg, Sweden*

Action cameras have found diverse applications in fisheries science, from recording animal behavior in and around fishing gear to evaluating gear performance and modifications. However, two primary challenges have traditionally been faced: limited battery life and constrained viewing angles. By combining action cameras with external batteries, extended running times could be achieved allowing for recordings of long fishing activities like extended trawl hauls or long soak times in passive gears. However, the issue of the limited angle of view remained: In case a camera was not mounted properly, i.e. the angle of view did not fit to what was intended to be recorded, recordings of one fishing activity might have to be discarded and redone. While the introduction of panoramic cameras addressed the issue of limited viewing angles with their often up to 360Â°recording capabilities, they lacked options for extending battery life.

In this study, we introduce a novel approach by combining a 360° camera with an external battery, enabling recording sessions up to 42 hours. As a practical application, we demonstrate the utility of this setup in investigating fish and crustacean behavior in pots but also animal behavior and habitat use around reef structures. This advancement not only opens doors to prolonged underwater observation, overcoming previous limitations and offering new insights into fisheries research and management, but also enhances the viewing experience through immersive virtual reality (VR) goggles. By utilizing VR technology, viewers can dive deeper into the recorded

content, experiencing a heightened level of engagement and understanding of what is happening under the surface.

(54) AI Catch - A pioneering concept with ultrasonic sonar sensors and a mechanical valve to optimize catches in beam trawl fisheries

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The European Landing Obligation intensified the relevance of minimising the discard rates within the discard intensive Belgian beam trawl fishery targeting sole. In recent years, the use of underwater cameras to optimize catches is gaining attention in fisheries worldwide. One of the challenges of beam trawling is the limited visibility underwater, which makes traditional camera systems ineffective. The AI catch system aims to overcome this challenge by using ultrasonic sonar sensors to detect fish in the net. Advanced imaging technology is developed to determine the length of fish, subsequently allowing software to determine whether the fish should be retained or directed towards an escape route through a valve positioned just in front of the codend. The system is connected to the vessel by an electrical cable via a specially controlled winch. Operation of the system can be monitored live on screen on the bridge. First trials on board of a Belgian research vessel are promising. The system is able to distinguish legally sized from undersized fish, but further development is needed to distinguish between different species. The system still requires technical improvements before it can be implemented on board of commercial trawlers.

(55) VISTools. Fishing vessels as automatic data-gathering platforms a win-win for fishers and scientists

Lancelot Blondeel[1], Femke Aers[1], Anthony Van De Sompele[1], Wim Allegaert[1], Els Vanderperren[1] & Hans Polet[1]

[1] *Institute for Agricultural and Fisheries Research (ILVO)*

A skipper of a fishing vessel has access to various sources of information that help in managing his/her work. Conventional onboard equipment tracks the location (e.g., GPS), monitors fishing activity (e.g., towing force), measures fuel consumption and registers landed catch (i.e., via an electronic weighing scale). This equipment gathers valuable data, but none of that is of any use if data are not integrated, stored or processed.

By automating data collection from these sources and coupling this information with economic parameters (e.g. fish prices and fuel prices), the VISTools project developed (1) a reliable IoT solution for fishing vessels, (2) a business intelligence tool for fishers and (3) a framework for sharing data for research purposes. With this approach, fishers gain new insight into the economic performance of their fishery (up to tow level), while exchanging valuable high-resolution data with research institutes.

This increased insight could trigger behavioural changes that increase the efficiency of the vessel and simultaneously reduce the impact on the environment. Additionally, the business intelligence tool incentivizes fishers to keep gathering information that has great scientific relevance and share this information under clearly defined conditions. Vessel owners can also share gear configurations on a trip-by-trip basis, allowing them to compare their performance per utilized

gear type. The current system is operational on 21 vessels, with installations planned on 16 more vessels in 2024, amounting to 62% of the Belgian fleet. This coverage offers new avenues for research including precision fishery, high-resolution impact assessments of fishing gear, catch prediction and fuel-efficiency models. With these models, decision support tools can be developed that balance the trade-offs between the profitability of a vessel, and minimising fuel consumption and the impact on the environment.

(56) Automatic 3D fish tracking to assess fish behavior inside trawls

Robin Faillettaz[1], Julien Simon[1], Dorothée Kopp[1], Matt Dawkins[2] & Thibault Pelletier[3]

[1] *DECOD (Ecosystem Dynamics and Sustainability), IFREMER, INRAE, L'Institut Agro, Lorient, France*

[2] *Kitware Inc., USA*

[3] *Kitware EU, France*

Understanding the behavior of fish inside fishing gears could help designing species-behaviour specific selective devices. Yet, observing behavior in situ requires both extensive sampling and data processing. Due to its time-consuming nature, the latter is the current bottleneck in handling imagery data. The project Game of Trawls aims at enabling active selectivity in trawl fisheries and relies on stereoscopic cameras for species detection in front or inside the gear. Such cameras enable to measure the size of individuals but may also enable to reconstruct the 3-dimensional movements and thus behavior of fish at the scale of the individual. We achieved this by developing a pipeline based on the architecture of the open-source software VIAME. It allows to calibrate any stereo camera, train a Mask-RCNN detector and compute inference and tracking of left and right images separately. Then, the stereo camera calibration is used for computing stereo disparity (depth maps), pairing the detections from both images and reconstruct the 3D positioning of each individual, automatically. The quality of the stereo-tracker is strongly influenced by the robustness of the mask detector model and the stereo calibration of the camera. The model has been applied on sequences of pelagic fish swimming inside a trawl, revealing the 3D movement of fish in the available volume, offering estimates of distances, at least relative, between individuals. This tool will continue to be improved but can already be used to extract fish tracks from much larger dataset.

(57) Sampling techniques and AI for fishing technology and fish behaviour introducing SNTech Catchcam and Seasensor products

Tom Rossiter[1]

[1] *SafetyNet Technologies, London*

Three years ago, SafetyNet Technologies (SNTech) launched CatchCam to the fisheries market. Designed with fishermen for fishermen, CatchCam sought to give commercial fishermen a tool to allow them to see their fishing gear in action.

Intended to be a tool for every gear type and all applications from the trawl doors to the codend and from the buoy line to the individual hook CatchCam, has delivered an agile fit for purpose solution into the fishermen and researchers' hands. The system offers multiple lighting solutions, configurable recording setting including timelapse with a battery life of up to 4 weeks. Robust enough to remain on a trawl tow after tow, the wireless charge and download systems make CatchCam ideal for use in such harsh environments. The user interface makes CatchCam a standout product for users, particularly the ability to review footage when the systems is on the deck during hauling, maximising precisions fishing and research time.

Building on the successes of CatchCam SNTech have developed an oceanographic multi-sensor for fishing applications. SeaSensor shares much of the CatchCam DNA, offering wireless charging and data transfer along with an intuitive App interface for configuration and accessing data. SeaSensor provides depth, temperature, turbidity, light intensity and 9axis accelerometer data. Salinity will be offered in 2024 and SNTech are working to provide a free port for specialist sensors such as O2 and pH.

Robustness and fit and forget applications are very important features in fisheries applications. SeaSensor uses many of the lessons learned while deploying CatchCam and both products can be deployed together, offering facilitating opportunities for layering data and extracting video for given conditions and providing digestible data for deep analysis. Both products lend themselves to machine learning especially given the breath and quantities of data that can be generated. Currently SNTech are working on interesting algorithms and hope to offer users the ability to filter out non-interesting content later in 2024. Further smart tools will be required to maximise the value of the data collected and SNTech are eager to work with the research community to research and develop these.

(58) SmartFishing –stereo-camera system for trawl observation

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[4] *FIUM GmbH & Co. KG, Institut für Fisch und Umwelt, Fischerweg 408, 18069 Rostock*

Camera systems play a crucial role in the investigation of living aquatic resources - especially in the vicinity of fishing gear, including trawls. The use of camera systems will also transform the harvest process and open opportunities to sharpen the catch process to meet economic and ecological demands. The fundamental challenges here are robustness, ease of use and the most comprehensive possible spatial detection of the objects to be recognised.

We present a stereo-camera system that addresses these challenges by using 3D-printing techniques to achieve best possible size-factor and robustness of the system. Based on the design, the system can be easily mounted e.g. in a trawl to observe the catch. The system can be used in autonomous mode and in tethered/realtime mode to allow AI-driven image recognition in fisheries and fisheries science. The presentation will introduce hardware, software and application.

(59) Commercially available technologies for monitoring fisheries efficiencies and impacts

Tom Rossiter[1]

[1] *SafetyNet Technologies, London*

The impacts of fishing on the environment are coming under ever greater scrutiny. Relatively speaking wild capture fish and fishing are some of the lowest impact food systems on the planet, however for some this is not enough and there is always room for improvement. Peter Drucker astutely observed that “if you can’t measure it, you can’t manage it.” In terms of fishing impacts on the seabed, very little is understood. There are however, well understood measures of efficiency, even if the fishing operation itself is not. The presentation will examine the methodology used in the UK FISP funded project - Assessment of seafloor fishing gear interactions and

ecosystem response to disturbance. It will explain the technologies used in the study and demonstrate how these technologies will be used to benchmark the nephrops trawl gear. Further it will explain how these technologies can be used by commercial fishermen on a daily basis to evidence their impacts and enable fishermen to reduce their impacts while maintaining or improving their catch efficiency. The presentation will include several videos to demonstrate the technologies at work and show the ease of use of the technologies by the crews. Finally, the presenter will discuss how these technologies can be used in fisheries certification and ecolabelling.

(60) Active selection progress: improving ActSel systems and facilitating their application to reduce bycatch

Craig S Rose[1]

[1] *FishNExt Research*

The availability of real-time video of fish passing through trawls motivated development of a system to release unwanted fish by triggering temporary net changes. Rose and Barbee (2022) developed and demonstrated a prototype of such an active selection (ActSel) system, that used a hydrodynamic kite to move a net panel covering an escape portal during normal fishing. Moving the panel to release fish uncovered that portal and funneled fish into it. Initial trials during commercial fishing were frustrated by inconsistent operation, failing to quickly identify effective kite adjustments. New and improved kite designs and adjustments were found through model trials, involving a team of fishery participants. The electromechanical actuator that adjusts the kite's control lines was redesigned around another underwater rotator that provided continuous position control and feedback. Subsequent field trials led to a configuration providing consistent and rapid panel shifts and useful insights for adapting the systems to new vessels. These will be applied to supporting 2024 ActSel deployments into relevant fisheries.

(61) Open sesame: design of a moving escape gate and species-specific reactions to an active selection device in the aft of a trawl

Melanie J. Underwood[1], Emma G. Jones[1], Karl Warr[2], Steve George[1] & Charlotte Bodie[1]

[1] *National Institute of Water and Atmospheric Research, Auckland, New Zealand*

[2] *Better Fishing Ltd, Napier, New Zealand*

Many fisheries face the challenge of encountering multiple species, some of which may not be desirable or permissible to catch. The effectiveness of fishing methods in catching specific species and avoiding or releasing others depends on the shape, size, and behaviour of the targeted species. Understanding species-specific behaviour can help improve fishing selectivity and facilitating more targeted fishing practices, particularly in cases where certain species have restricted quotas. In this study, we investigated the behaviour of common New Zealand fish species, such as snapper and red gurnard, in a demersal trawl. We quantified their reactions to a moving escapement gate and evaluated the impact of behaviour on escape success. Furthermore, we discuss the advantages and challenges associated with using a moving gate to release non-targeted species at fishing depth during the capture process.

(62) Technology-based precision fishing with real-time decision making in demersal trawl fisheries

Ludvig A. Krag[1], Mette M. Svantemann[1], Ercan Avsar[1] & Fletcher Thompson[1]

[1] *Technical University of Denmark, DTU Aqua*

Increasingly ambitious management plans and stronger public opinions on the ecological cost of bottom trawling force the industry to reduce unwanted bycatch, impact on the seabed, and consumption of fossil fuel to maintain access to fishing areas and market. Technology-based fishing has the potential to transform trawling from a blind to an informed process. This transformation is a prerequisite for developing precision fishing as it enables the operator to actively make real-time decisions during the fishing operation. In recent years, DTU has developed a pipeline to digitize the catching process in demersal trawls. This pipeline consists of the use of a real-time camera, sediment suppressing system, and automatic catch description using machine learning. The ongoing development of real-time decision-making tools can help individual fishers to make the fishing operation with demersal trawls much more targeted, efficient, and transparent. We demonstrate examples of decision-making tools for different demersal trawl fisheries. These are established based on real-time image processing of the catching process using machine learning and involve automatic description and logging of the species and size composition inside the trawl. We show how this information can be presented to the individual fisher in the wheelhouse and, for example, be shared between vessels to obtain a comprehensive spatiotemporal understanding of the current and historical species and size distribution on the fishing ground. Finally, we discuss the state of the development of technology-based precision fishing as well as drivers and barriers for commercial up-take of the technology.

(63) Abandoned, lost or otherwise discarded fishing gear (ALDFG)- Introducing MyGearTag Acoustic lost gear technology

Tom Rossiter[1]

[1] *SafetyNet Technologies, London*

Abandoned, lost or otherwise discarded fishing gear has long been an issue for the commercial fishing industry. The problem persists today however, awareness has increased inside and outside of the fishing industry and with this awareness has come scrutiny focus on finding solutions. The issue of ALDFG is a complex one with many causes and as such there is not one single solution. In recent years several products have come to the market that offer fishers tools to mitigate against losing fishing gear and aiding with its recovery. Succorfish, a UK technology company have now launched a product that provides a cost effect solution for locating lost gear even when it moves over long distances. The MyGearTag solution comprise of battery power acoustic beacons that are attached to the fishing gear and a deck unit that communicates with the beacons via an app. The dunk transducer comes in a Pelicase for easy storage and can be shared amongst several vessels as it is designed to be used only when gear is lost. The system range is 3km omnidirectional. Battery life is 60 days, and the beacon is rated to 250m depth. The beacon costs are circa $500, and the deck system is less than $1,000. The system has been trialled in trawl and static net fisheries and trials and commercial deployments are underway outside the UK.

(64) Spatial and temporal distribution of fish near wind turbines using underwater video cameras

Keith Hankowsky[1], Chris Rillahan[1] & Pingguo He[1]

[1] *University of Massachusetts Dartmouth - School for Marine Science and Technology*

Offshore wind is a burgeoning industry off the East Coast of the US. Offshore wind development will transform previously homogenous habitat into complex three-dimensional habitat with turbine structures. Understanding the spatial utilization of fish in the vicinity of a wind turbine

structure and connectivity between structures is important in evaluating the overall impact of large-scale offshore wind development. Traditional survey methodologies like trawl surveys can be limited in their ability to detect change in fish abundance, population structure, and community composition directly adjacent to fixed structures due to navigational concerns and gear constraints. This project aims to investigate the effect of turbines on the spatial distribution of fish and invertebrates and seasonal changes in distribution. Benthic and pelagic baited stereoscopic video systems were deployed in four mooring systems at fixed distances from the turbines: close proximity to the turbine (0m), 100m, 200m, and 450m during daylight hours. Each camera was deployed for 1 hour. So far, 144 deployments have been conducted with another year of sampling to be carried out. Fish abundance, population structure, and community composition will be analyzed in relation to the distance from the turbine. Preliminary observations indicate that the turbine structures are utilized by a diversity of fish including black sea bass and scup. This project complements an acoustic tagging and monitoring component to understand the distribution, residence, and connectivity of fish between wind turbines in large wind farms.

(65) Smart Buoy Technology for Gear Marking and Data Collection

Kortney Opshaug[1]

[1] *Blue Ocean Gear*

The open ocean presents challenging conditions for operating fishing gear, with fog, storms, and tidal or current forces all hindering the ability to locate gear during fishing operations. This causes significant fuel use spent searching for gear, as well as gear loss if it moves far from where it was set or becomes temporarily dragged under the surface. Lost gear leads not only to ghost fishing, but also increases the risk of marine mammal entanglement. In addition, other vessels may come into conflict with gear they cannot see, causing damage to their vessel as well as the equipment.

The marking of fishing gear that is active out on the water is a critical factor in preventing gear loss and improving fuel efficiency out on the water. Smart Buoy technology is expanding in its adoption due to its ability to improve the efficacy of gear recovery by the end of a fishing season, as well as the benefits provided to fishing fleets. As an example, over 600 pieces of gear have been tracked for harvesters in three Canadian provinces this past spring, primarily for gear loss prevention. Discussion of these deployments will be presented to highlight the role of technology in enabling sustainable practices within the fleets while also providing economic benefits.

Beyond gear marking capability, additional sensors onboard the Smart Buoys provide an efficient means of gathering high-density oceanographic data from deployed gear in regions where this can be lacking. This information can be useful to the fishing industry, as well as shared (with agreement from the harvesters) with other entities. The development of technology that can create a bridge between the advantageous placement of fishing gear in coastal zones of economic importance and other ocean industries and research that rely on ocean condition information is key in expanding a relevant database with broad application.

9 National Reports

WGFTFB-members were asked prior to the meeting to prepare summaries of current and expected research related to the activities of the WG within their country. Twenty national reports were received: Argentina, Australia, Belgium, Canada, Denmark, England, France, Germany, Iceland, Ireland, Italy, Japan, Northern Ireland, Norway, Portugal, Scotland, Spain, Sweden, The Netherlands, and the United States of America.

This section lists the national reports submitted by WGFTFB members, alphabetically sorted by country name. The contents of the individual national reports were NOT discussed by the group and not edited by chairs, and as such they do not necessarily reflect the views of the WGFTFB.

9.1 Argentina

9.1.1 Contact person

Ricardo Roth, National Institute for Fisheries Research and Development (INIDEP), rroth@inidep.edu.ar

9.1.2 Summary

- Design of selectivity device to reduce the capture of rays in the Hake fishery.
- Square and diamond mesh selectivity.
- Use of underwater camera to determine species behavior.
- Use of LED lights to determine behavior differences between hake and shrimp.
- The durability of different threads will be studied to determine the degradation time and thus reduce ghost fishing.
- Marking fishing gears

9.1.3 Projects

9.1.3.1 Bycatch of PETS

Project Full Title: Reduction the catch of rays in the hake fisheries

Project Timeframe: June 2020 – November 2024

Institution(s): INIDEP

Contact person: Franco Rubio, frubio@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS[1]? Yes

Could this project indirectly decrease bycatch of PETS? Yes

[1] Protected, Endangered and Threatened Species = all marine mammal, seabird and turtle species and any protected, prohibited (see Table 1.4 of the WGEF 2019 report for a list of EU-prohibited elasmobranchs) or zero TAC elasmobranchs and protected fish species (see Table 18 WGBYC 2019 report),

Is the project addressing ALDFG[2]? No

Summary: Due to the vulnerability of chondrichthyans (sharks and rays) to fishing exploitation, in our country management measures were established for their bycatch, determining a maximum landing limit per tide, the prohibition of target fishing of chondrichthyans, the prohibition of the practice of "finning" and the prohibition of the use of "fish hooks" for the return of these species (Res. CFP No. 4/2013 and No. 7/2013). For this reason, in the aforementioned Workshop, the evaluation of a selective device aimed at reducing bycatch of rays in the hake fishery was also proposed, which was designed by INIDEP.

9.1.3.2 Trawl gear codend selectivity for Hake

Project Full Title: Study of square and T90 mesh selectivity

Project Timeframe: May 2020 – July 2023 (extended until December 2024)

Institution(s): INIDEP

Contact person: Ricardo Roth, rroth@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary

During the workshop for the preparation of the 2019 Annual Operational Plan, of the Program "Strengthening the Management and Protection of Marine Coastal Biodiversity in Key Ecological Areas and the Application of the Ecosystem Approach to Fisheries (EEP)". It was agreed to work together with the private sector in the development of selective devices that adapt to their requirements and to the biological demands for the conservation of the resource.

In principle, it was agreed to carry out selectivity experiments with a square mesh codend and a T90 mesh codend.

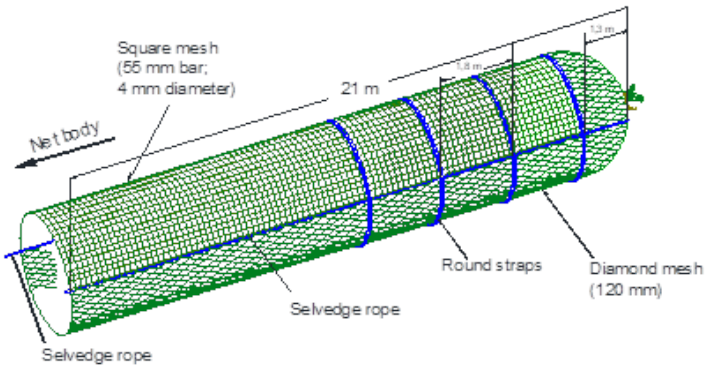


Figure 9.1. Square mesh codend

[2] ADLFG - Abandoned, lost or otherwise discarded fishing gear; related FAO-report here

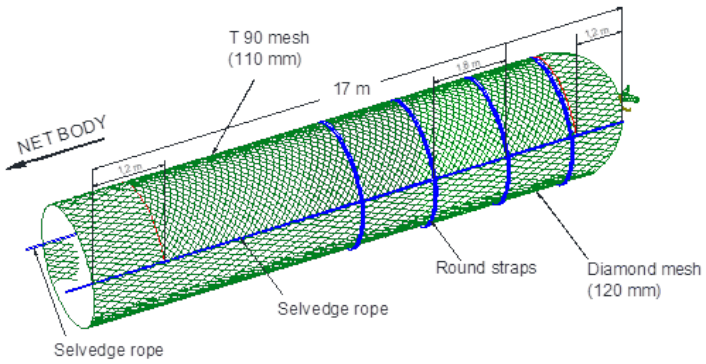


Figure 9.2. T90 mesh codend for Argentine hake fishery.

9.1.3.3 Towing speed

Project Full Title: Use of a modified trawl net towed at different speeds to reduce hake catch in shrimp fishery.

Project Timeframe: September 2022 – October 2023

Institution(s): INIDEP – Pesquera Deseado A.S.

Contact person: Ricardo Roth, rroth@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary

Based on a proposal made by PESQUERA DESEADO A.S the use of a modified trawl net was towed at different speeds and the catch of hake and shrimp were studied in a first experience. Modifications were made to the trawl net designed in the first instance and new experiences were carried out.

The results showed that there were no differences in bycatch between that obtained with the modified net and that obtained with the control net, for the trawl speeds tested.

9.1.3.4 fishing gear marking

Project Full Title: Fishing gear marking tests.

Project Timeframe: September 2022 – October 2023

Institution(s): INIDEP – Solimeno e hijos A.S.

Contact person: Ricardo Roth, rroth@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: Durability tests and detection of problems in the fishing operation were carried out with the use of marks placed on different parts of a commercial bottom trawl net.

The work shows the variation on the condition of marks over almost a one-year experience through direct observation and photographic recording, made with marks placed on a bottom trawl net belonging to a vessel engaged in hake fishing.

The number of hauls, towing time, and total catch of each fishing day, since the beginning of the experience was obtained from the F/V's fishing reports.

Can be seen that from September 14, 2022, when the experience started, to June 13, 2023, when the last review of the marks was carried out, the vessel made 13 fishing trips, a total of 239 hauls, with a time of trawling time of 675 hours and a total catch of 3113.36 metric tons, mainly of common hake (*Merluccius hubbsi*).

Because of the net is no longer used, due to its technical condition, and was dismantled, the wing tip markings were returned to the INIDEP Fishing Gear and Capture Methods Development Program.

Different figures show the evolution of the marks condition used during the experience.

It is concluded that there is the possibility of losing the marks due to snagging, as could be seen in the first review, that the location of the marks must be carefully studied and will depend on the type of fishing gear that is marked and the fishing operation that is carried out. Is made, that metal marks such as those tested, can last as long or longer than the gear where they are used, depending on the conditions of use and location.

During the test no alterations or inconveniences were observed in the operation of the trawl gear.

Friction of the mark with other elements, such as the seabed, can alter the information recorded on it. Therefore, the possibility of replacing the mark must be analysed, justifying its replacement, if its use is regulated as occurs in provision No. 4/2023 of the National Directorate of Fisheries Coordination and Supervision of Argentina, in which establishes a unique number for each fishing gear.

9.1.4 Future projects and Ideas

9.1.4.1 Fish behaviour regarding selectivity devices

Project Full Title: Use of underwater camera to determine species behaviour.

Project Timeframe: July 2023 – November 2025

Institution(s): INIDEP

Contact person: Ricardo Roth, rroth@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Possibly

Is the project addressing ALDFG? No

Summary: The behaviour of different species will be studied through the footage and videos provided by an underwater camera incorporated to INIDEP**.**

Two Rayfin Sub-C underwater cameras were incorporated; one through an agreement with the FAO and another through a donation from a fishing business association.

9.1.4.2 Use of LED lights

Project Full Title: Use of LED lights to increase selectivity of hake in shrimp fishery.

Project Timeframe: May 2024 – November 2026

Institution(s): INIDEP

Contact person: Franco Rubio, frubio@inidep.edu.ar

Link(s): www.inidep.edu.ar

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary

The problem of hake bycatch in the shrimp fishery in Argentina dates to the 1980s. Different experiences with selective devices have been carried out, from 1988 to date. Devices with single and double grids were mainly tested (Nordmore Grid type, and DISELA II type (designed by INIDEP). They have had acceptable and varied results, according to the concentrations of hake and shrimp and, also to the sizes of them.

Currently, the size of the shrimp has increased, reaching the size of juvenile hake. For this reason, grid devices have decreased their efficiency, capturing more juvenile hake and letting the largest shrimp escape.

Faced with this situation, it was proposed to investigate the use of LED lights, in order to observe if there is any change in the behaviour of the species involved, which may collaborate in reducing the catch of hake in the shrimp fishery.

9.2 Australia

9.2.1 Contact person

Steve Eayrs (report compiler). Fisheries Research and Development Corporation. Email. steve.eayrs@frdc.com.au

9.2.2 Summary

A variety of projects in Australia relevant to WGFTFB have focused heavily on improving the selectivity of bottom fish trawls and prawn trawls. The selectivity of gillnets is a rapidly growing focus around the country as fears grow that the sudden closure of the Queensland inshore gillnet fishery, due to concerns over the mortality of TEP species such as sawfish, dugongs, and sea turtles, will be repeated in other fisheries. One very innovative project attempts to revolutionize catch processing on prawn trawlers in Queensland using an innovative catch hopper system that also reduces bycatch mortality. Another has tested the efficacy of escape gaps in crab pots and modifications to reduce sea turtle mortality.

9.2.3 Projects

9.2.3.1 Improving and promoting fish-trawl selectivity in the Commonwealth Trawl Sector (CTS) and Great Australian Bight Trawl Sector (GABTS) of the Southern and Eastern Shark and Scalefish Fishery (SESSF)

Project Timeframe: September 2020 – September 2024

Institution(s): AFMA, CSIRO, Fishwell Consulting, NSW DPI, SETFIA, GABTS

Contact person: Matt Broadhurst. Email. matt.broadhurst@dpi.nsw.gov.au

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? Yes / No (delete as appropriate)

Summary: Fish-trawl fisheries are important throughout southeastern and southern Australia, with >35 species targeted in different sectors providing ~>15 000 mt valued at >$60 million p.a. Most of the catch comes from the Commonwealth Southeast Trawl (CTS) and Great Australian Bight Trawl Sectors (GABTS) of the Southern and Eastern Scalefish and Shark Fishery (SESSF). Like all trawl fisheries around the world, none of the traditional, conventional gear configurations used in the SESSF are entirely selective for the targeted species and, at some times and locations, non-target catches, including juveniles of the targeted species, those sought in other commercial and recreational fisheries and protected species are caught and discarded.

Twenty years ago, recognition of the wastage associated with the mortality of fish-trawl bycatch led to research assessing simple modifications to codends involving bycatch reduction devices (BRDs), including square-mesh panels (that were first developed in other fisheries) to allow small fish to escape. Some of these BRDs were shown to substantially reduce unwanted catches and led to legislative changes by 2006. While such changes have been positive, because the fisheries have variable target species (with many managed by quota), at some times and locations, large numbers of unwanted catches are still caught and discarded.

In recent years, some trawl fishers have investigated simple modifications to gears (including changes to mesh size and orientation at strategic locations) and fishing operations (trawl-monitoring equipment to facilitate directed targeting) to reduce bycatches and with reports of variable effectiveness. The utility of these recent modifications needs to be assessed and, where appropriate, their fleet-wide testing and adoption encouraged. It is also well-established that over the past two decades, similar bycatch issues in overseas trawl fisheries have led to various novel technical and operational solutions for improving selectivity.

Considering the above, the aim of this four-year research project is to work with trawl fishers in the CTS and GABTS to prioritise, assess and then refine modifications designed to minimise unwanted bycatches while maintaining target catches. In doing so, the project will support the wide-scale voluntary adoption and ongoing exploration of appropriate best-practice technologies that cumulatively improve the harvesting of important Australian fish stocks.

9.2.3.2 Mitigating threatened species gillnet bycatch in northern Australia

Project Timeframe: 25/05/23 – 7/09/25

Institution(s): Charles Darwin University, Northern Territory Government, Western Australian Government, Northern Territory Seafood Council.

Contact person: Kyne, Peter M. Principal Investigator/Chief Investigator. Email. Peter.Kyne@cdu.edu.au

Link(s):

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? Yes / No (delete as appropriate)

Summary: Mitigating threatened species bycatch in northern Australian gillnet fisheries is a major management challenge. This project will test novel mitigation devices and assess alternative gear to reduce bycatch of EPBC listed sharks, sawfishes, and turtles. In partnership with industry, trials will assess the effectiveness of devices to elicit a response in bycatch species, their ability to reduce bycatch levels, and their impact on target species. An assessment of alternative gear types will consider the feasibility of transitioning to fishing gear with lower bycatch levels. Trial outcomes will provide industry and managers with proven options to implement threatened species mitigation strategies in northern gillnet fisheries.

9.2.3.3 Evaluation of New Fish Eye Escapement designs in Commercial Prawn Nets

Project Timeframe: June 2023– February 2025

Institution(s): Western Australia Fishing Industry Council and the Department of Primary Industries and Rural Development (DPIRD).

Contact person: Marshall Thompson. Email. Marshall.thompson@wafic.org.au

Link(s): www.wafic.org.au

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: In 2020 a grant was obtained from Ocean Watch for the design and development of a new fisheye exclusion device in cooperation with the Sharks Bay trawler Operators and DPIRD. The development of this exclusion device is now complete, and we will undertake comprehensive trials and analysis on commercial vessels within the fishery.

These trials aim to test these devices to accurately determine the improved escapement of sea snakes, seahorses and other ETP and unwanted bycatch.

These newly developed exclusion devices have been designed to assist the removal of seagrass and debris which block existing designs and reduce the effectiveness of ETP species escapement.

Our project aims to test the effectiveness of the newly designed bycatch exclusion devices for specifically in the Sharks Bay prawn fishery due to net configuration and environmental conditions.

Through design innovation, these devices aim to reduce the number of interactions between the vessel's crew and ETP species by increasing the escapement of major ETP species (Sea snakes) from nets while trawling. This will improve conservation outcomes for threatened species listed in the EPBC Act interacting with commercial wild-catch fisheries. The reduced interaction with sea snakes will also improve crew safety.

To date, we have undertaken first-stage trials to allow us to plan a major survey, which will occur during the 2024 Shark Bay Prawn season.

9.2.3.4 Prawn trawl sea-snake bycatch reduction device – Assessment, refinement, and extension

Project Timeframe: 2023 – ongoing

Institution(s): Fishing Untangled Pty. Ltd., Sea Harvest Australia.

Contact person: John Wakeford. Email. johnwakeford@fishinguntangled.com.au

Link(s):

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Dispersed around Australia's large coastline are numerous prawn fisheries, and collectively they produce around 20Kt of produce per annum with a value of around AUD$300m. The commerce associated with this form of primary industry and its contribution to Australia's economy, especially in remote areas, is often under-rated. Maintaining these prawn fisheries is therefore crucial to Australia's future prosperity.

Prawn trawling has the capacity to catch a myriad of unwanted species due to the need to make trawl nets from small aperture netting material to retain commercial sized prawn. Endeavours to reduce this bycatch extend back several decades now and have resulted in bycatch landings of most species approaching/reaching acceptable levels. Judgement here befalls fisheries management organisations (State and/or Commonwealth government) and independent third-party accreditation organisations/companies such as the Marine Stewardship Council (MSC). Today several Australian prawn fisheries have been judged as "sustainable" by the MSC, and this "sustainability" rating extends to bycatch species of most concern, i.e., the Threatened, Endangered and Protected species.

The Exmouth Gulf Prawn Managed Fishery (EGPMF) and Shark Bay Prawn Managed Fishery (SBPMF) jointly gained MSC accreditation in 2015, and even though landings of relevant TEP species such as turtles were considered to be well in hand, sea-snakes were seen as the group requiring most attention.

In response to this need, Fishing Untangled (FU) was contracted by Sea Harvest (SH) to develop a new form of BRD for expelling sea-snake, and trials of the prototype in 2023 on the quad-rigged Sea Harvest trawler FV Point Cloates exceeded expectations: an 81% reduction in sea-snake landings from April 21 to Oct 20 (i.e., 79 x landings from 2 x port-side nets equipped with standard TED and SMW BRD, and 15 x landings from starboard-side nets equipped with Sea-snake TED/BRD and SMW BRD). Pleasingly, the 'small finfish' bycatch over a six-night period in late October (20 x trawl shots; port-side catch v starboard-side catch) was also reduced by 18%, and the loss of prawn catch via the "new/extra" escape holes was <10 prawn per trawl shot, according to UW footage collected on 3 x c.3hr trawl shots.

The next logical step in the development of this new device is to undertake a more thorough assessment of its performance (including escape processes and survivability of escapees), apply refinements where appropriate, and then explore extension of the design more broadly in the EGPMF as well as to other prawn fisheries where sea-snake bycatch reduction needs attention (e.g., the Northern Prawn Fishery and Qld East Coast Otter Trawl Fishery). To that end, Sea Harvest and Fishing Untangled will seek financial support from the FRDC to undertake this work in 2024/25 (refer FRDC 2023-155).

9.2.3.5 Mitigating Development, construction, and evaluation of a fish-first hopper, catch handling system for Queensland prawn trawlers.

Project Timeframe: July 2023 – Dec 2024

Institution(s): Curtin University, Ella Mae Fishing Pty Ltd, Cashcor Engineering Pty Ltd

Contact person: Janet Howieson. Email. J.Howieson@curtin.edu.au

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

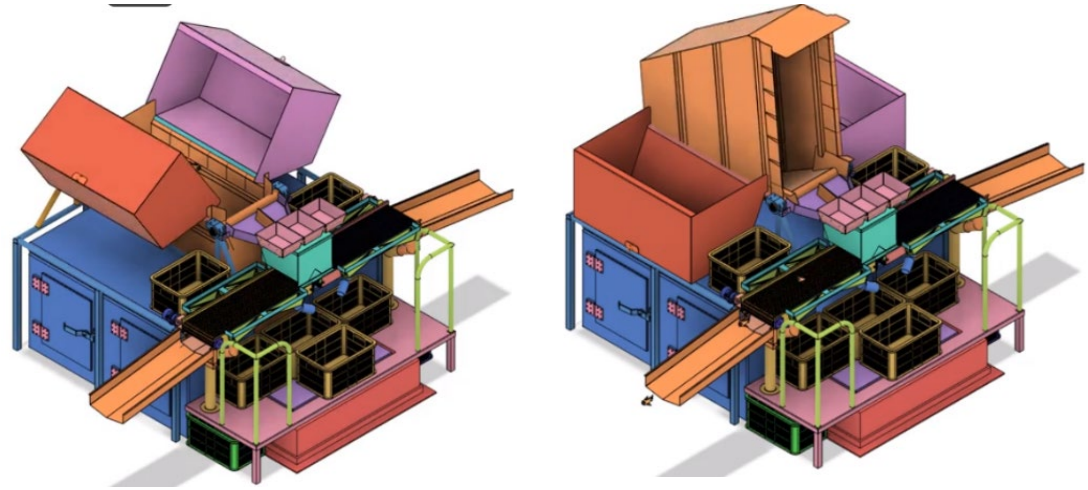
Is the project addressing ALDFG? No

Summary: This project aims to transform catch handling onboard Australian prawn trawlers from the current labor intensive, unpleasant, and hazardous process involving the demise of all vulnerable bycatch components and significant damage/spoilage of the seafood products (Figure 9.3); to a much less hazardous work environment, where vulnerable bycatch is returned to the sea alive before any other catch-handling task is undertaken, and product quality is maximized by immediate decontamination/washing. The central innovation to the new catch handling system is termed a Fish-First Barrel Hopper (FFBH), which allows all catch from the codend to be immersed immediately in fresh-flowing seawater for cleaning, preservation of life, and catch-component separation (Figure 9.4a); and then an orderly flow of catch material across picking conveyors and back to the sea, if not of commercial value (Figure 9.4b).

Resoundingly, the objective of the innovation is to achieve a great positive effect on the physical and mental wellbeing of crew, the survivorship of bycatch, and the quality/value of the resulting seafood products. The co-design project for the development and testing of a Fish First Barrel Hopper (FFBH) has made reasonable progress. A solid group of project partners for the first stage of the project has been formed. Significantly, this includes contracting Cashcor Engineering, based in Cairns, to produce a 3D model of a prototype FFBH to be fitted to FV Silda for field trials. Work to date has produced a 3D model that reflects basic elements of the proposed concept that was available prior to the project. The model contains detailed design features that addresses the functionality of the equipment in many aspects and there has been strong attention to overall dimensioning such that it fits in the space available onboard Silda and will work into the flow of product processing that occurs there. The design has been developed to ensure broad applicability across the Australian prawn trawl fleet and safety/stability issues and regulations are being considered and addressed in the product development process.

A preliminary 3D model is complete, but a significant element is yet to be fully developed and finalised in the model and associated engineering drawings, the drive mechanisms for the arrangement. Proposals for this matter were covered by the initial concept, but the engineering team at Cashcor have alternative options in mind and given the complex and largely unspecified nature of the working environment for the machine (onboard a trawler in a wide range of sea conditions) and the machines' dynamic characteristics, they have yet to commit to a specific approach to this part of the design. They have proposed building a physical scale model of the equipment so that experiments can be undertaken to test various ideas. This is the latest 3D model https://a360.co/49zAJDD.

Figure 9.3. Traditional sorting of the catch. Crew manually separate prawns from the catch before disposing of bycatch overboard via a chute.



a b

Figure 9.4. The catch is released from the codends into one of two hoppers, which tip the catch into the barrel hopper (a). The barrel hopper then rises upwards (b) and tilts to release the catch onto a conveyor belt, where prawns are separated from the catch. A specialised baffle system prevents water surging in the hopper (not shown in image).

Proposed benefits of the new catch handling system include:

- A cleaner, less arduous, and less hazardous work environment for crew, whereby the catch is prewashed and presented without manual assistance in a controlled fashion to crew to sort the catch.
- Trawler operators can offer crew onboard conditions that more closely match modern expectations, leading to more enthusiastic interest from high-caliber individuals to work at sea.
- Fewer injuries to crew, both from contact with hazardous animals in the catch and injuries to from repetitive manual labor.
- Improved post-release survivorship of bycatch because the catch is immediately emptied from the codends into a barrel hopper filled with seawater.
- Improved catch quality due to less physical damage and reduced biological spoilage, and potential for improved catch value.

9.2.3.6 Reducing impacts on threatened, endangered, and protected species in the Queensland East Coast Otter Trawl Fishery

Project Timeframe: July 2023 – December 2025

Institution(s): Department of Agriculture and Fisheries, Queensland, Fisheries Research and Development Corporation

Contact person: Matthew Campbell, Department of Agriculture and Fisheries, Queensland. Email. matthew.campbell@daf.qld.gov.au

Links: https://www.frdc.com.au/project/2023-009

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Project fieldwork has just commenced, and data from only fisher testing a Tom's Fisheye (TFE) has been analysed to date. This fisher installed a TFE in each of his port nets and recorded relevant information from 183 trawls in northern Queensland between October-December 2023 (Figure 9.5a). During this time, 567 sea snakes were caught, 417 (~73.5%) of which were caught in nets without a TFE. A generalised linear model (GLM), where sea snake catch rate (numbers per trawl) was modelled using a Poisson distribution as a function of codend type (Prescribed BRD vs TFE), indicated that there was a significant difference ($\chi^2 = 130.85$, d.f. = 1, $P < 0.001$) in catch rates between gear types. The GLM estimated that the mean catch rate of sea snakes was 3.0 snakes trawl^{-1} (S.E. = 0.15) from nets with prescribed BRDs, compared to 1.1 snakes trawl^{-1} (S.E. = 0.09) for the TFE-equipped nets (Figure 9.5b).

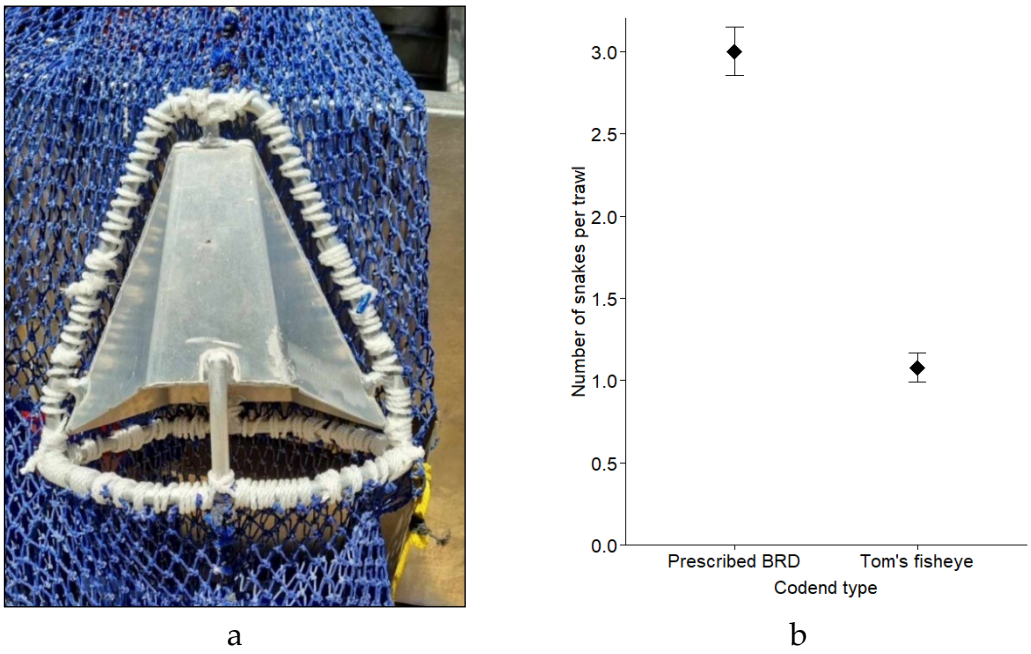


Figure 9.5. a) Tom's Fisheye and b) estimated mean number of sea snakes per trawl for nets with prescribed BRDs, compared to those equipped with Tom's Fisheyes, from a trial conducted in north Queensland by a Townsville-based trawl fisher.

Part way through the trial, large Moreton Bay bugs were found to be escaping through the TFE. As a result, the fisher reduced the size of the escape opening in the TFE using several zip ties. This measure prevented the escape of bugs, but had no significant effect (χ^2 = 2.53, d.f. = 1, P = 0.111) on the catch of sea snakes. The modified TFE was used for the remainder of the trial.

Generalised linear mixed modelling (GLMM) was used to determine the proportion of sea snakes escaping a trawl as a function of independent variables such as latitude, depth, trawl duration, TFE position in the codend, the presence of the zip ties, and total catch size. Preliminary results indicated that the probability of escape was correlated to the amount of bycatch caught: the larger the catch, the more snakes escaped. However, the amount of bycatch caught also increased with depth, latitude and trawl duration. As a result, the probability of escape was estimated as a function of trawl duration (hours), the position of the TFE in the codend (number of meshes from the drawstrings, 70 or 80) and the presence of zip ties (0=absent, 1=present).

The GLMM indicated that the probability of escape significantly (χ^2 = 4.401, d.f. = 1, P = 0.036) increased (β=0.914, S.E.= 0.436) with trawl duration. However, the position of the TFE in the net (χ^2 = 0.036, d.f. = 1, P = 0.849) and the presence of the zip ties (χ^2 = 1.482, d.f. = 1, P = 0.223) had no significant effect.

Additional devices being tested included a prototype fish window to facilitate the escape of teleosts and sea snakes and a modified TED (narrow bar spacing) to reduce the catch of small elasmobranchs.

9.2.3.7 Improving bycatch reduction strategies and escape vents in Queensland crab fisheries

Project Timeframe: Sept 2022 – April 2024

Institution(s): Department of Agriculture and Fisheries, Queensland, Fisheries Research and Development Corporation

Contact person: Julie Robins, Department of Agriculture and Fisheries, Queensland. Email. julie.robins@daf.qld.gov.au

Links: https://www.frdc.com.au/project/2021-119

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? Maybe

Summary: The current research investigated the performance of escape vents in mud crab pots to determine if current Queensland fisheries regulations should be revised to provide better commercial outcomes (i.e., retention of legal male mud crabs) whilst minimising the bycatch of non-legal crabs, finfish and other bycatch species such as water rats.

The ongoing issue of marine turtle interactions with crabbing apparatus, including a recent increase of reported interactions in the StrandNet data base, led to the research also collating available information about these interactions to support a risk mitigation strategy for the fishery's interaction with protected marine turtle species.

Summary of results:

- Analyses found statistically significant regional variation in mud crab morphometric relationships between notch width and carapace height.
- Carapace height represents the dorso-ventral height of mud crabs and is relevant to the performance of the 120 x 50 mm rectangular escape vent. Results indicate that almost all near-legal male mud crabs (i.e., >99%) are greater than 50 mm in carapace height and would

be unable to exit a crab pot via the 120 x 50 mm escape vent. (Female crabs cannot be retained in this fishery.)

- Results indicate that a large proportion of near-legal male mud crabs (i.e., 148 to 151 mm carapace width - CW) would be able to exit the 105 mm round escape vent.
- Based on morphometric analysis, the 75 x 60 mm escape vent prevents male crabs of 115 mm CW or greater exiting, as crabs of this size have a mean carapace length of 76 mm or greater. Results indicate that the 75 x 60 mm escape vent is of limited benefit in allowing mud crabs of less than 150 mm CW to escape.
- The annual numbers of marine turtles entangled in crabbing apparatus in 2021 and 2022 were 53 and 50 respectively. Of the 240 records of marine turtles in StrandNet (2011 to 2023) attributed to crab pot entrapment, 89% were reported dead, and 11% were alive. Of the 295 records of marine turtles in StrandNet (2011 to 2023) attributed to floatline entanglement, 56% were reported dead, 39% were alive and 5% had an uncertain fate.
- Efforts to mitigate this impact are ongoing and results yet to be reported.

Results are to be considered by management, Fisheries Queensland and the Crab Working Group as part of the Harvest Strategy arrangements for the Queensland Crab Fishery. The crab fishery is an important commercial and popular recreational fishery in Queensland. Its sustainability could be improved by regulating mud crab pots to contain appropriately sized escape vents that retain legal male mud crabs, whilst reducing the bycatch of sub-legal-size crabs, fin fish and other protected species such as water rats. Sustainability could also be improved by more detailed definitions of crabbing apparatus (pot and floatline) in the Queensland Fisheries Regulations, with the aim of reducing the risk of marine turtle entrapment – which has been a long-standing issue for this fishery.

9.2.4 Future Projects and Ideas

9.2.4.1 Fish LIGHT (Low Impact Gear & Harvest Technology); Inshore fishery alternative and innovative gears partnership

Estimated Project Timeframe: January 2024 – June 2030

Institution(s): Queensland Department of Agriculture and Fisheries / Fisheries Research and Development Corporation

Contact person: Samuel Williams, Samuel.Williams@daf.qld.gov.au; Steve Eayrs, Steve.Eayrs@frdc.com.au; Crispian Ashby, Crispian.Ashby@frdc.com.au.

Link(s): https://www.frdc.com.au/project/2023-154

Collaboration welcome?: Y

Funding secured?: Y

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The removal of large mesh gillnets from Australia's Great Barrier Reef World Heritage Area (GBRWHA), will considerably reduce the catch of sustainable fisheries resources within Queensland's inshore fisheries. These changes will likely lead to an underutilisation of sustainable, wild-caught seafood from these regions. The primary objectives of the Fish LIGHT program is to support the development of a commercial inshore fishery that maximises the value of the inshore fishery resource and does so with a low ecological footprint.

This program of works is to support the trial, implementation, and evaluation of innovative and alternative low-impact harvest technologies (fishing gears) within Queensland's inshore fisheries. The new fishing methods to be trialled as part of the first stage will range from exploring enhancements of existing low-impact gear types, through to trials of innovative harvest technologies. The alternative low-impact harvest technologies will first be trialled in order to demonstrate their triple bottom line credentials. After this, the second stage will commence, which will support the broader implementation, and evaluation of commercial application over an additional three-year period.

The program of works will also explore additional opportunities to enhance the economic value and social profile of the fishery, such as third-party accreditation to ensure that any new harvest technologies align with global best practice standards, product value adding to enhance profitability margins, and improvements in social licence.

9.2.4.2 Determining the Role of AI in the fishing industry

Project Full Title:

1. AI-assisted bycatch monitoring in trawl fisheries

2. The use of AI to examine and interpret catch history, and environmental conditions to record historical fishing patterns before the IP within the industry is lost.

Estimated Project Timeframe: Month 2025– Month 2027

Institution(s): TBC

Contact person: Marshall Thompson. Email. marshall.thompson@wafic.org.au

Collaboration welcome?: Y

Funding secured?: N

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? Possibly

Summary:

To look at all the work currently being undertaken and develop a nationally coordinated approach to using AI in the fishing industry to avoid duplication.

Use AI to examine, record and report Bycatch in real time to meet MSC, WTO, and ERA requirements and to alleviate the need for independent verification.

Use AI to investigate historical fishing IP currently held by the aging fishers through the use of catch records climatic and environmental model.

9.3 Belgium

9.3.1 Contact person

- Mattias Van Opstal, ILVO – Institute for Agriculture Fisheries and Food Research, Mattias.vanopstal@ilvo.vlaanderen.be
- Jasper Van Vlasselaer, ILVO - Institute for Agriculture Fisheries and Food Research, Jasper.VanVlasselaer@ilvo.vlaanderen.be

9.3.2 Summary

- LED There Be Light: many experiments were performed with mixed results; best results obtained with illuminated BRP to reduce bycatch of plaice. Finished;
- The Accurate Selection: refining sorting device settings and gathering data; the system reduces unnecessary cooking of bycatch and reduces workload but needs further improvement. Finished;
- TIPTOP: Focus on lab trials and development of innovations for passive fisheries with pots. Starting;
- POLUX: At sea trials with commercial fishers in France to find the potential of LED light in pots, focusing on scallops, crustaceans and cephalopods. Starting;
- VISTools: Growth in participating vessels from 5 to 37 beam trawl vessels (full installations), expansion of system by installing fuel-consumption sensors on main and auxiliary engines (21 vessels completed and sending data, rest is planned in 2024), further development of a business intelligence tool for commercial fishing vessels (focus on fuel-efficiency). Ongoing;
- Visserij Verduurzaamt: Continuation of second cycle, 51 vessels participating with updated indicators. 22 consumer-facing businesses joined system but improvements needed for higher uptake in market (main focus of Visserij Verduurzaamt Strategy project). Ongoing;
- CIBBRINA: The overall aim of the project is to work together with fishers, authorities and other relevant stake-holders to minimise - and, where possible, eliminate – incidental bycatch of priority Protected, Endangered and Threatened (PET) marine species in the North-East Atlantic, Baltic and Mediter-ranean regions. Starting.

9.3.3 Projects

9.3.3.1 LED there be Light

Project Full Title: LED there be Light

Project Timeframe: January 2022 – December 2023

Institution(s): ILVO – Flanders Research Institute for Agriculture, Fisheries and Food

Contact person:

Mattias Van Opstal, mattias.vanopstal@ilvo.vlaanderen.be

Jasper Van Vlasselaer, jasper.vanvlasselaer@ilvo.vlaanderen.be

Link(s): https://ilvo.vlaanderen.be/en/sectors/marine-sector/fishing-industry

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary

'LED there be Light' aimed to develop and optimize innovations in different fisheries practiced by Belgian fishers to reduce by-catch and/or optimize commercial catches. In this way, the project tried to assist the sector in dealing with the landing obligation and Brexit.

Many innovations were tested by cameras and catch comparisons, the most significant were:

- A new type of ground gear, which roles over the seabed, replacing heavy chains for catching sole, reducing weight of the gear, contact with the seabed, and fuel

consumption. We saw a reduction in sole smaller than 27 cm, while other catches were maintained.

- We tested whether the colour, white, blue and green would lead to different escape rates for undersized plaice through a square mesh panel in the belly of the net (BRP). There was no significant difference between the colours and other setups using the lights where less successful than the one with the lights placed on the BRP.
- Light on the beam itself was also tested but showed limited results in sole fishery but was effective at reducing bycatch of fish in shrimp fisheries, without negatively impacting commercial shrimp catches.
- We did trails with light in flyshoot (scottisch seine) and ottertrawl fisheries but stumbled upon technical difficulties, resulting in non-conclusive datasets but some lessons learned about the needed structure of the lights and rigging.
- Trails for using light in potfishing for brown crab (*Cancer pagurus*) gave interesting results. For green light and the fluorescent netting of Euronete, no significant differences were found. Also, the Lindgrenn-pitman lanterns did not give any significant result. With the Pisces lights, we did get significant effects on the catches of the brown crab (but not for green light). Blue light reduced the amount of crabs in the traps, the majority of them being undersized. White light saw a large increase in catches of the crab.
- In the lab we conducted an experiment to investigate the behaviour of plaice regarding light, placed on a miniature beam. The plaice did not react to the beam or light. We conclude that plaice will react to light only when it is already startled by something like the sand cloud and approaching chains.
- In cooperation with Marelec, we are started to develop and test a smart catching device called I-catch. It is based on a detection ring that uses sound pulses and its received echo to determine whether a (commercially sizable fish) passes through the ring. Based on that information, two "gates" can open or close leaving the fish to pass down into the codend or escape through the sides of the net. First trials showed promise as the detectionring managed to pick out the fish and survive fishing, but further development is necessary to the whole system before it is ready for commercial trials.

The project was conducted in collaboration with "Redercentrale" and aimed at an intensive communication with and strong participation from the sector. Brainstorm sessions and workshops were organized. All findings and results are communicated with and to the rest of the sector through meetings with interested fishermen, ship owners and the Rederscentrale. Knowledge will be shared during international meetings, which will also allow to allocate resources in the most efficient way.

Figure 9.6. Overview of project structure.

9.3.3.2 The Accurate Selection

Project Full Title: The Accurate Selection

Project Timeframe: January 2020 – December 2023

Institution(s): ILVO – Flanders Research Institute for Agriculture, Fisheries and Food, de Boer RSV, WR09, WR289, Vissersbond

Contact person:

Mattias Van Opstal, mattias.vanopstal@ilvo.vlaanderen.be

Jasper Van Vlasselaer, jasper.vanvlasselaer@ilvo.vlaanderen.be

Link(s): https://ilvo.vlaanderen.be/en/research-projects/automatic-shrimp-triage

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary

In this project, machine builder de Boer RVS, the Research Institute for Agriculture, Fisheries and Food (ILVO) and skipper Jan-Jurie van Eekelen of WR 9, Adriaan van Eekelen of the WR289, and Vissersbond were working together in a study around an on-board innovative processing line for shrimp fishing vessels. In 2016 – 2020, the prototype sorting device was tested. Now, in this project with a new design, more detailed information was acquired on the working of the on-board sorter. It uses a detection line, based on camera images and automatic image recognition, that sorts the catch into marketable shrimp, shrimp that are too small and other bycatch. Shrimp smaller than 6.8 mm and bycatch are returned to the sea as soon as possible. Market worthy shrimps are further divided into three market classes that are stored separately on board.

The goals were to optimize the sorting of shrimp into commercial fractions, map the losses of bycatch and shrimp throughout the process and evaluate the immediate and short-term survival of the bycatch. The on-board sorter managed to reduce the amount of bycatch being cooked, releasing them back into the sea. The software used for discerning undersized shrimp from marketable shrimp showed potential but will need to be further developed by Raytec. The fishers who used it are happy and want to continue using the innovative sorting device.

9.3.3.3 Tip-Top

Project Full Title: Testing Innovations in Potfisheries: Towards Optimal Pots

Project Timeframe: January 2023 – December 2025

Institution(s): ILVO – Flanders Research Institute for Agriculture, Fisheries and Food

Contact person:

Mattias Van Opstal, mattias.vanopstal@ilvo.vlaanderen.be

Jasper Van Vlasselaer, jasper.vanvlasselaer@ilvo.vlaanderen.be

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary

The TIP-TOP project aims to develop, optimize, and test innovations for pot-based fisheries, with a focus on attracting various species significant for Belgian fishermen. Targeted species include the North Sea crab, spider crab, sole, plaice, and the saw-toothed shrimp. These innovations are designed to reduce bycatch, optimize commercial catches, and establish alternative fishing methods. The project is a crucial step, following the SYMAPA initiative, in assisting the fishing sector in coping with challenges such as rising fuel prices, declining catches, changing ecosystems, and reductions in fishing grounds.

Key Objectives:

1. Research on Innovations

- 1.1 Development of SYMAPA Innovations: Building upon insights from the SYMAPA project to understand and optimize the impact of previously tested innovations.
- 1.2 Scientific Literature Analysis: Monitoring scientific literature for developments in passive fisheries and researching the biological background of target species to optimize innovation relevance.

2. Lab Testing of Innovations

- 2.1 Lab Setup: Properly configuring the lab for each innovation, ensuring the availability of target species and developing necessary protocols.
- 2.2 Test Execution: Conducting lab tests on chosen species to evaluate the effectiveness of innovations.
- 2.3 Image Analysis: Utilizing a developed camera system to analyze images, extracting valuable information for potential further testing or refinement of innovations.

3. Establishment of Semi-Natural Research Site

- 3.1 Site Exploration: Identifying requirements for a semi-natural research site that bridges the gap between the lab and the sea.
- 3.2 Site Application: Detailing site selection with necessary specifications for conducting experiments.
- 3.3 Site Development: Installing all elements required for research in a semi-natural habitat, creating a state-of-the-art research center.

4. Testing Innovations in Semi-Natural Habitat

- 4.1 Test Setup: Configuring the site for each innovation, ensuring the availability of target species and developing necessary protocols.
- 4.2 Test Execution: Conducting experiments to evaluate the innovations in a semi-natural habitat.
- 4.3 Image Analysis: Using the camera system to analyze images, guiding decisions on further research or potential integration into sea-based fishing practices.

5. Development of Multi-Use Camera System

- 5.1 Camera System Plan: Exploring specifications for a multi-use camera system, aligning it with project requirements through market research.

- 5.2 System Construction: Procuring and assembling necessary components to create a functional multi-use camera system for extended, low-light imaging.

The TIP-TOP project not only supports the fishing sector in transition but also contributes to the development of an innovative, ecologically and economically sustainable fisheries model for the future.

9.3.3.4 POLUX

Project Full Title: Study of the impact of light on species caught with pots

Project Timeframe: January 2023 – December 2025

Institution(s): ILVO – Flanders Research Institute for Agriculture, Fisheries and Food

FROM nord – P&O for fishers from Boulogne-Sur-Mer

Contact person:

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Jasper Van Vlasselaer, jasper.vanvlasselaer@ilvo.vlaanderen.be

Arthur YON – a.yon@fromnord.fr

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary

Pot fishing appears as a promising sector. However, only a few studies on the gear improvement possibilities have been conducted. It is then important to start thinking about means of innovation for pots, enhancing its selectivity and promote the catch of new species while fishing sustainably with a low impact on the marine environment. Another advantage of the development of pot fishing could be to promote the attractivity of the fishing industry and to attract young people.

Light is used to attract marine species since centuries. This then allows to consider that the use of light could expand the catch spectrum of passive fishing gears such as pots, by allowing the catch of a few individuals of a species that would be more highly valued (reduced environmental impact). It is however necessary to conduct more research in order to better understand the potential impacts of such a fishing method.

The POLUX project will focus on developing this type of study. The first issue of POLUX would be to acquire new knowledge concerning the impact of light on the species usually caught with pots. Indeed, light can have an impact on a given species, and have a totally opposite effect on another. This spectrum of potential effects is further expanded when individuals belonging to different classes/ life stages are targeted. The second issue would be to study the impact of light on new potentially valuable species through pot fishing, usually caught with other fishing gears. Eventually, the third issue would be to evaluate the selective potential of light in pot fishing. In the waters of the Dover Strait, this would include to evaluate the possibility to continue to catch crustaceans, while avoiding the catch of spider crabs *Maja brachydactyla*, highly present and difficult to valorize.

The POLUX project will address several technical and scientifical questions raised by these three issues, through a holistic approach, involving fishing professionals and scientists. This approach will combine the collection of biometric data (sex, size, weight of individuals, …), environmental

data (temperature, depth, turbidity, salinity), behavior data (underwater images) as well as statistical analysis.

The POLUX project will cover three objectives, corresponding to the issues mentioned above:

1. Acquire more knowledge concerning effects of light on the different species caught with pots
2. Evaluate the potential of light on the diversification of pots metiers
3. Study the selective capacity of light in pot fishing

9.3.3.5 VISTools III

Project Full Title: VISTools III

Project Timeframe: 2018 - June 2022

Institution(s): ILVO

Contact person: Lancelot Blondeel, lancelot.blondeel@ilvo.vlaanderen.be

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

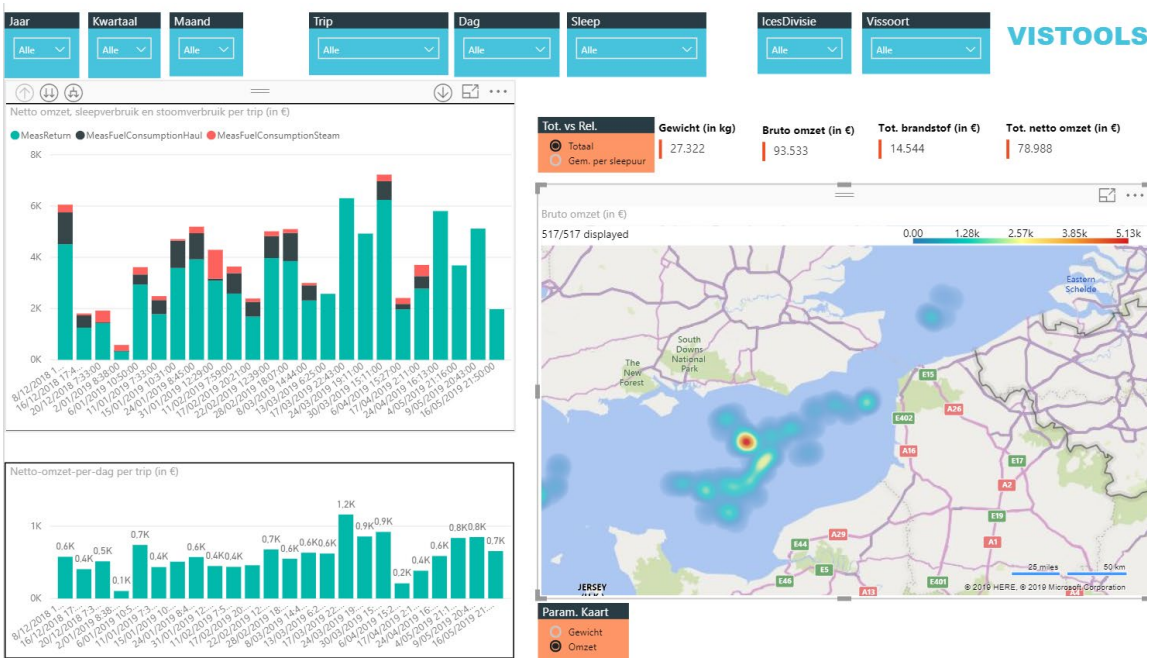
Is the project addressing ALDFG? No

Summary:

A skipper of a fishing vessel has access to various sources of information that help him manage his work. Navigation instruments and sensors track the location (e.g., GPS/VMS), monitor any fishing activity (e.g., towing force, depth), fuel consumption and register landed catch (i.e., via an electronic weighing scale). These sensors gather valuable data, but none of that are of any use, if data are not integrated, stored or processed.

By automating data collection from conventional on-board equipment, adding additional sensors (CTD, TBD) and coupling this information with economic parameters (e.g. fish prices and fuel prices), the VISTools-projects achieved;

The hardware development of a central hub for the automatic data gathering on board of a fishing vessel (concentrator). This includes data from conventional on-board equipment (towing force, fuel consumption, catches, GPS and depth) and additional sensors fixed to the fishing nets (CTD) or other parts of the vessels (for instance, fish hold temperature)



The development of a business intelligence tool for fishers presenting the processed data in a simple and accessible way on graphs and maps, ready for fisheries evaluation and planning (VISTools Analytics).

With this approach, fishers gain new insight in the economic performance of their fishery, while exchanging valuable high resolution oceanographic data with research institutes. This is a fully automatic process that does not entail unnecessary burdens on the fishers themselves and has been fully operational on a fishing vessel for over a year.

This increased insight of fishing activities could trigger behavioral changes that increase the efficiency of the vessel and simultaneously reduce the impact on the environment. Additionally, the business intelligence tool incentivizes fishers to keep gathering information that have great scientific relevance and share this information under clearly defined conditions. This data could open new research possibilities including catch prediction models, decision support tools, avoidance of sensitive areas, and real time closures. This high resolution of spatial information can also lead to better advice to fisheries management and governmental bodies (e.g., real time monitoring of quota usage).

Recent developments

The upscaling of the system to 5 vessels has been expanded to 37 vessels. Focus has shifted to fuel consumption, where external partners (shipbuilders and engineering departments of Universities) are approached to use VISTools data to provide advice on improving fuel consumption on current vessels, but also designing the next generation of fishing vessels that use alternative fuels.

To support this new trajectory, vessels have installed fuel consumption sensors on main and auxiliary engines. On 3 vessels, a torsion sensor will be installed with a speed sensor (doppler – *speed through water*) to better estimate the transfer of energy from the engine to the propellor and the effective thrust in the water. Coupling this with engine data, which is already gathered, will lead to better estimates of engine loads and burning temperatures, which guide the decisions on which alternative fuels are the most promising.

9.3.3.6 Visserij Verduurzaamt

Project Full Title: Visserij Verduurzaamt Cyclus II

Project Timeframe: 2024 - March 2025

Institution(s): ILVO

Contact person: Lancelot Blondeel, lancelot.blondeel@ilvo.vlaanderen.be

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

The Belgian fishing fleet, mainly composed of beam trawlers, has faced numerous challenges in the past decade. High fuel prices led to economic hardship, competition for space at sea encroach on the known fishing grounds (windfarms, MPA's, Brexit), and the use of beam trawls is criticized for its lack of selectivity and the large impact on the marine environment. The beam trawl also limited the possibility of obtaining certification through initiatives like MSC which, with consumers becoming increasingly environmentally aware, puts fishers at risk of losing market access. Additionally, fishers were wary of interference from fisheries management and scientific institutions, limiting constructive exchanges between stakeholders.

To meet these challenges, Belgian stakeholders decided to develop a sustainability assessment tool called VALDUVIS which utilises 10 indicators to monitor the social, economic and ecologic progress of the Belgian fleet. This system is currently used to guide the Belgian fishers to further improve their scores through a voluntary fishery improvement program. The aim has been to apply a step-by-step approach with progressively increasing thresholds for participation and to gradually convince and prepare fishers to change their current practices. This would enable the entire fleet to evolve into a more sustainable direction that would benefit everyone in the long term. Early on, motivating vessel owners to participate proved to be difficult, with only 3 of the 65 vessel owners showing interest in the initiative. A change of heart came with the introduction of a market recognition, which was awarded to those who achieved a set minimum score and declared to participate in the improvement program. Consequently, participation increased to 51 vessel owners in one year. The current cycle is the second, which runs on an updated set of indicators with new thresholds.

9.3.3.7 CIBBRINA EU LIFE BYCATCH PROJECT

Project Full Title: Coordinated Development and Implementation of Best Practice in Bycatch Reduction in the North Atlantic, Baltic and Mediterranean regions.

Project Timeframe: September 2023 – June 2029

Institution(s): LNV (NL); CSIC (ES); MI (IE); SRMar (PT); TiHo (DE); USC (ES); PFA (NL); AZTI (ES); KFO (IE); DPPO (DK); Fishfix (PT); SAR (BE); WUR (NL); TI (DE); CETMAR (ES); SDN (NL); SPFA (UK); IPMA (PT); SWF (UK); HAFRO/MFRI (IS); ANP-WWF (PT); SRMP (PT); StAndrew (USTAN) (UK); DTU (DK); SLU (SE); LRU (FR); RBINS (BE); ILVO (BE); MWC (UK); UoG (UGLA) (UK); IWC (INT); UU (NL); IFREMER (FR); NMFRI (PL); IMR (NO); ICES (INT); DGRM (PT); OFB (FR); MINROL (PL); DEFRA (UK); MITECO (ES); FVM (DK); SUHI (UK); NfD (NO); MAPA (ES); BMU (DE); PELAC (NL); CNPMEM (FR); LIFE (INT); OSPAR (INT); MSC (INT); SSWAC (INT); EFCA (EU); EEFPO (UK); BirdLife (INT); Europeche (INT); AFPO (UK); SFSU (USA); BSAC (DK); ASCOBANS (INT); BMEL (DE); PC (ES); NFFO (UK); FGC (ES); FNC (ES); NSAC (NL); NOAA (); Bocorn BV (NL); OceanCare (INT); NWWAC (IE); BFN (DE); EAPO (INT); 3Dshapes (NL); IFAW (UK); EFFOP (DK); Accobams (INT); ProSea (NL); IFAW (NL); ISPRA (IT); RVO (NL)

Contact person: Tim Plevoets, tim.plevoets@ilvo.vlaanderen.be

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary:

The overall aim of the project is to work together with fishers, authorities and other relevant stakeholders to minimise - and, where possible, eliminate – incidental bycatch of priority Protected, Endangered and Threatened (PET) marine species in the North-East Atlantic, Baltic and Mediterranean regions (all WPs), to meet the requirements of relevant EU Directives and Regulations (e.g. Habitats Directive, Technical Measures Regulation) by optimising, developing and evaluating mitigation methods and support tools / processes, and working to ensure their long-term implementation.

The project will involve:

- Applying an adaptive, multidisciplinary, multi-taxa and participatory approach to develop, test and implement effective bycatch mitigation measures to reduce the incidental bycatch of priority marine mammals, sharks, rays, birds and sea turtles in those gear types with a high bycatch risk (including both static and towed gears), thus finding solutions for bycatch which focus on the fishers and the practical constraints which they face
- Building on results from previous work through new targeted case studies within the project;
- Create a 'safe environment' to share information and develop viable solutions for all stakeholders involved;
- Development of a long-term stakeholder engagement strategy and communication strategy;
- Focus on socio-economic effects including addressing any potentially negative impacts of implementing incidental bycatch mitigation on the fisheries sector, the livelihoods of individual fishers, and seeking approaches to incentivise sustainable practices;
- Working with national and regional fishery management authorities and other relevant bodies such as the FAO to ensure the implementation of recommended bycatch mitigation measures;
- Ensuring that long-term funding mechanisms are in place, to address financial constraints and opportunities with regards to incidental bycatch monitoring and mitigation;
- A suit of approaches to incidental bycatch monitoring (e.g., use of Remote Electronic Monitoring (REM) and apps on mobile devices to support estimation of bycatch and integration of information from strandings and interviews in data-poor situations), to obtain the best possible fishing effort data and to achieve a step change in the reliability of bycatch rate estimates;
- Building on current best practice (e.g., in OSPAR, HELCOM, ICES, ASCOBANS, IWC) to develop methods to assess the conservation implications of incidental bycatch in data-rich and data-poor situations.

The project started in September 2023, and development of the WP's and CS's will continue in in 2024. It is funded until 2029.

9.4 Canada

9.4.1 Projects

9.4.1.1 Whalesafe Fishing Gear

Project Full Title: Evaluating the fishing performance of various technologies designed to mitigate entanglement with whales.

Project Timeframe: Jan 2022 – Jan 2025

Institution(s): Fisheries and Marine Institute

Contact person: Paul Winger, Paul.Winger@mi.mun.ca

Summary: Several experiments are underway to evaluate the performance of whalesafe fishing gear in Canada. The research responds to a recent government regulation requiring all fixed untended fishing gears to be "whalesafe" in order to protect endangered cetaceans such as the North Atlantic Right Whale. This includes features that allow gear to break-away or cut-away in the event the gear is entangled with a whale. We are evaluating various weak ropes, weak links, weak sleeves, time-tension line cutters, as well as rope-on-command systems.

9.4.1.2 Aligned Rolling Footgear

Project Full Title: Reducing seabed impacts of bottom trawls in Canada's Arctic Ocean.

Project Timeframe: April 2018 – June 2024

Institution(s): Fisheries and Marine Institute; Nunavut Fisheries Association

Contact person: Tomas Araya-Schmidt, Tomas.Schmidt@mi.mun.ca

Summary: A 6-year project is currently underway to design and test novel footgear concepts to reduce seabed impacts of bottom trawls in Canada's eastern Arctic. This is a partnership with factory freezer trawlers operating in NAFO Division 0A/B between Baffin Island and Greenland. Fisheries of interest include Northern shrimp and Greenland halibut. To date, novel footgear designs have been conceived and evaluated using physical models in a flume tank. Building on previous research on "aligned" footgears (e.g., Winger et al. 2018), our latest designs are now both "aligned" and "rolling". Full-scale prototypes have now been constructed. At-sea testing is ongoing.

9.4.1.3 Reducing bycatch in the redfish trawl fishery

Project Full Title: Using modified codends to reduce bycatch of endangered white hake (*Urophycis tenuis*) in the redfish (*Sebastes* spp.) fishery in the Gulf of St. Lawrence

Project Timeframe: Sept. 2023 – Jul. 2025

Institution(s): Fisheries and Marine Institute

Contact person: Shannon Bayse, Shannon.Bayse@mi.mun.ca

Summary: This project will compare the size selectivity between T0 and T90 codends for white hake (*Urophycis tenuis*) in the redfish trawl fishery in the Gulf of St. Lawrence. The southern Gulf of St. Lawrence stock of white hake are considered endangered and white hake bycatch will be a choke species for the upcoming redfish trawl fishery. The effectiveness of a T90 codend to release white hake is currently unknown.

9.4.1.4 Reducing bycatch of Greenland shark in trawls

Project Full Title: Developing techniques to reduce Greenland shark bycatch in Northern shrimp trawls

Project Timeframe: June 2022 – Dec. 2024

Institution(s): Fisheries and Marine Institute

Contact person: Shannon Bayse, Shannon.Bayse@mi.mun.ca

Summary: Greenland shark (*Somniosus microcephalus*) are commonly captured as bycatch in Arctic fisheries. This project aims to modify shrimp trawl grid systems to allow easy escape of large bycatch species, such as Greenland shark. Multiple grid systems were tested to document any change in the catch rate of the target species, Northern shrimp (*Pandalus borealis*).

9.4.1.5 Efficacy of shrimp grids to release skates

Project Full Title: Evaluating the effectiveness of Nordmøre grids to release skates (family Rajidae) in a shrimp trawl

Project Timeframe: June 2022 – Dec. 2024

Institution(s): Fisheries and Marine Institute

Contact person: Shannon Bayse, Shannon.Bayse@mi.mun.ca

Summary: This study will use video analysis of skates (family Rajidae) interacting with a Nordmøre grid to determine the efficacy of the grid to release skates quickly, maximizing potential post-catch survival.

9.4.1.6 Are collapsible pots more effective to capture sablefish than longlines?

Project Full Title: Comparing the effectiveness of collapsible pots to longlines in the sablefish (*Anoplopoma fimbria*) fishery

Project Timeframe: Jan. 2024 – Nov. 2028

Institution(s): Fisheries and Marine Institute

Contact person: Shannon Bayse, Shannon.Bayse@mi.mun.ca

Summary: The sablefish fishery in the Northwest Pacific Ocean has experienced significant issues with marine mammal interactions. The fishery is considering a shift to a collapsible pot to mitigate the concern. This project will compare the effectiveness of a collapsible pot to longlines to determine if this would be an effective switch.

9.4.1.7 Environmentally friendly snow crab pot design

Project Full Title: Environmentally friendly snow crab pot design: improving sorting of undersized crabs and increasing catch efficiency

Project Timeframe: September 2023 – August 2024

Institution(s): Fisheries and Marine Institute

Contact person: Tomas Araya-Schmidt, Tomas.Schmidt@mi.mun.ca

Summary: Snow crabs are currently harvested using baited conical pots, once the bait is depleted, the mesh size allows a proportion of the undersized crabs to exit the pot at depth. However, studies have shown undersized crabs to be up to half of the catch composition.

These crabs are brought to the surface and discarded, causing an unknown amount of fishery-induced mortality. The number of active pots fished each year is estimated to be in the hundreds

of thousands, therefore undersized crab mortality can decrease indices of biomass and recruitment in the snow crab population, therefore can potentially reduce commercial catches. Furthermore, the design of the traditional conical pot prevents snow crabs from effectively locking onto the bait odour plume as they climb up past the plume to reach the top entrance of the pot, lowering the number of crabs that enter the pot. Several studies have proven this for other crab species, where side entrances that lead straight to the bait, increased pot entry success up to 20 times. This project aims to develop an innovative pot by studying the behaviour of snow crabs when exposed to undersized crab escape mechanisms and various pot entrances. This new pot design will increase efficiency and size selection on an individual quota-managed fishery, which will lead to a reduction in fishing effort, fuel consumption, bait usage and whale entanglements while increasing the profitability and sustainability of the fishery.

9.4.1.8 Behavioural Approaches to Reduce Redfish Bycatch

Project Full Title: Evaluating Behavioural Approaches to Reduce Redfish Bycatch in Offshore Shrimp Trawling

Project Timeframe: August 2022 – March 2025

Institution(s): Fisheries and Marine Institute

Contact person: Tomas Araya-Schmidt, Tomas.Schmidt@mi.mun.ca

Summary: Beginning in 2020, DFO science surveys determined that redfish (*Sebastes mentella*) biomass and recruitment (redfish smaller than 150 mm in length) have been increasing considerably in recent years in the Davis Strait region, throughout the Labrador Shelf southward to Northern Newfoundland in 3K. The emergence of large redfish biomass has resulted in increasing volumes of juvenile redfish being caught by offshore vessels targeting Northern shrimp. The project will develop a new behavioural bycatch reduction technology for the fishery, including functional prototypes developed and tested aboard commercial vessels.

9.4.1.9 Whalesafe Fishing Gear

Project Full Title: Whalesafe Fishing Gear

Project Timeframe: Jan 2021 – March 2024

Institution(s): Fisheries and Oceans Canada

Contact person: Edward Trippel, Edward.Trippel@dfo-mpo.gc.ca

Summary: To help protect North Atlantic right whales and other whale species, DFO is working closely with the fishing industry, Indigenous groups and other partners to make fishing gear safer for whales. Whalesafe gear falls into two general categories:

- Low breaking-strength rope or links that are designed to break at 1,700 lbs. of force. This gear will make it easier for entangled whales to free themselves and reduce the risk of serious injury; and
- Systems that allow fishing gear to be deployed without vertical line in the water, either rope-on-demand systems that stow buoy lines at the sea floor, or inflatable bag systems that eliminate buoy lines. These are released by an acoustic signal sent from the fishing vessel.

The timeline to test and implement requirements to use low breaking strength fishing gear in non-tended, fixed gear and trap and pot commercial has been extended to 2024 for fisheries in Atlantic Canada and Quebec. DFO's main objective is to prevent entanglements from happening.

We are doing this by opening fisheries before North Atlantic right whales arrive in our waters, by closing fishing areas where and when whales are detected, and by removing ghost gear. Fisheries and Oceans Canada's Whalesafe Gear Adoption Fund (WSGF) is providing up to $20

million towards the purchase, testing and refinement of whalesafe gear with the goal of making this innovative equipment ready to use. 2024 is a year of voluntary adoption of low breaking strength gear for selected coastal lobster fisheries. We want to make sure that low breaking-strength fishing gear is safe, effective at protecting whales, and readily available to support harvesters with the transition to new gear, and to support the advancement of rope-on-demand gear technology. The Whalesafe Gear Adoption Fund also provides support to Canadian manufacturers to increase the domestic supply of commercially ready whalesafe gear.

9.4.1.10 NL-DFO Multi-Species Survey Trawl

Project Full Title: Modifications to the Campelen 1800 Shrimp Survey Trawl

Project Timeframe: December 2019 – December 2024

Institution(s): Fisheries and Oceans Canada

Contact person: Truong Nguyen, Truong.Nguyen@dfo-mpo.gc.ca

Summary: This project aims to make our survey trawl more user friendly and less susceptible to damage. This increases cost effectiveness, improves productivity at sea (e.g., optimizing use of vessel time when on program, i.e. reduce overall repair time) as well as the financial and human resources that are required to maintain the surveys. The proposed trawl modifications are being evaluated as part of a larger vessel replacement strategy. We are using numerical simulations, flume tank testing, and comparative fishing. At sea trials were conducted in 2021-23 using two new vessels (CCGS Capt. Jacques Cartier and CCGS John Cabot) and two vessels nearing their retirement (CCGS Alfred Needler and CCGS Teleost). Results are currently under investigation.

9.4.1.11 Double threshold weak link for Snow Crab Fisheries

Project Full Title: Testing and deployment of the MF2S (double threshold weak links) for snow crab fisheries to reduce whale entanglement

Project Timeframe: March 2024- March 2026

Institution(s): Merinov

Contact person: Éloïse Lemaire (eloise.lemaire@merinov.ca)

Summary: This project aims to complete and deploy the double threshold weak link developed in a previous project that began in 2019. Designed specifically for snow crab fishing activities, this weak link ensures compliance with the threshold breakage requirements for North Atlantic Right Whale disentanglement while maintaining fishing efficiency. The project is a collaborative effort involving MFS2 industries, Les Industries FIPEC Inc, the Association des crabiers Gaspésiens and the Université du Québec à Rimouski.

9.4.1.12 SOS Fantôme - Detecting and Recovering ALDFG

Project Full Title: SOS Fantôme - Reducing the threat of ghost fishing to aquatic species at risk in the Gulf of St. Lawrence

Project Timeframe: April 2022 - March 2026

Institution(s): Merinov

Contact person: Alex Fréchette (alex.frechette@merinov.ca)

Summary: As a continuation of projects addressing ghost gear issues since 2019, Merinov and its partners will advance methods for detecting and recovering lost or abandoned fishing gear. This project will focus on developing retrieval tools specifically adapted for trawler boats and equipment. The effectiveness and efficiency of these new tools, along with those developed in

previous projects (including trailing and circular retrieval gear), will be evaluated during retrieval missions.

9.4.1.13 Use of redfish for bait

Project Full Title: Development and testing of redfish co-products as bait for the snow crab and lobster fisheries.

Project Timeframe: April 2019 – December 2025

Institution(s): Merinov

Contact person: Lise Chevarie (lise.chevarie@merinov.ca)

Summary: Two of Quebec's most significant trap fisheries, snow crab and lobster, are major drivers of the Canadian economy. However, fish harvesters are finding it increasingly difficult to source quality bait at reasonable prices. Traditional baits, mainly consisting of whole fish or pieces of fish such as mackerel, herring, and yellowtail, are in sharp decline in the Gulf. With restrictions on mackerel and herring bait fishing since 2022, the industry is seeking alternatives. The recent increase in redfish availability and expected higher landings present an opportunity. This project aims to develop and test the palatability and catch performance of various redfish-based bait recipes, focusing on coproducts (unused parts), in both experimental and commercial settings, and compare them with traditional baits. This project is being conducted in collaboration with Fruits de Mer Madeleine and La Vague.

9.4.1.14 Smart Gear 3 – Selective gillnets

Project Full Title: Improving the selectivity of Greenland halibut gillnets (*Reinhardtius hippoglossoides*) in Quebec

Project Timeframe: July 2023- March 2024

Institution(s): Merinov

Contact person: Stéphanie-Carole Pieddesaux (stephanie.pieddesaux@merinov.ca)

Summary: Greenland halibut fisheries generated $4.4 million in revenues in Quebec in 2021, with landings totalling 1,085 tonnes. However, gillnet fishing for halibut is associated with several recognized issues, such as poor species selectivity (FRCC, 1994). In previous projects, Merinov conducted a literature review and developed a gillnet prototype designed to minimize bycatch. Replicas of this prototype were made and tested by three different halibut fishing crews, alongside traditional gillnets, to compare performance and bycatch characteristics during the fishing season. This project was carried out in collaboration with the Association des Capitaines Propriétaires de la Gaspésie Inc.

9.4.1.15 Greenland Halibuts pots

Project Full Title: Development of alternative fishing gear for Greenland halibut (*Reinhardtius hippoglossoides*) in Quebec

Project Timeframe: July 2023 – March 2024

Institution(s): Merinov

Contact person: Stéphanie-Carole Pieddesaux (stephanie.pieddesaux@merinov.ca)

Summary: The fishing gear used in Greenland halibut fisheries, particularly gillnets, is known for its low selectivity. Additionally, fish often suffer damage from entanglement in the gear, reducing their market value. This project's objective was to conduct preliminary testing of fishing pots developed by Smart Ocean, aiming to adapt them specifically for this industry under

Quebec's fishing conditions. This project was carried out in collaboration with Les Industries FIPEC Inc. and SmartOcean.

9.4.1.16 Metaman 2 - Fishing Vessel noise reduction

Project Full Title: Noise reduction of commercial fishing vessels using resonant metamaterials to support sustainable fishing with reduced noise impact on endangered species.

Project Timeframe: April 2024 - March 2026

Institution(s): IMAR, Merinov

Contact person: Éloïse Lemaire (eloise.lemaire@merinov.ca)

Summary: Underwater noise pollution is an increasingly recognized issue due to its negative effects on marine life, which are being extensively studied. This pollution arises from coastal and offshore human activities (such as dredging, seismic surveys, and windfarm development), marine traffic, and fishing operations. This project focuses on fishing vessels and aims to ensure the sustainability of the industry. Recent research indicates that most underwater noise produced by fishing vessels originates from the motor. Utilizing resonant metamaterials, a technique already employed in the aviation and automotive industries, this project will develop and test customized resonators on fishing vessels. Additionally, tools and materials will be created to raise awareness within the fishing industry through science popularization. Led by Innovation Maritime, this project is conducted in collaboration with Merinov, Sherbrooke University, First Nation Wolastoqiyik Wahsipekuk, and Sensea Canada.

9.5 Denmark

9.5.1 Contact person

- Valentina Melli, DTU Aqua, vmel@aqua.dtu.dk
- Junita D. Karlsen. DTU Aqua, juka@aqua.dtu.dk

9.5.2 Summary

The following areas represent the core-activities of DTU Aqua in 2023:

- **machine vision**, underwater observation technology, and video processing for **real-time information during fishing and on board** fishing vessels using Electronic Monitoring;
- the **hydrodynamic performance** of different gear components, as well as the quantification of their physical impact on the seabed;
- the use of **acoustic methods for observation of fish behaviour** in relation to fishing gears
- the potential of **biodegradable** materials for gillnets fisheries;

As well as the usual gear development in collaboration with the industry.

9.5.3 Projects

9.5.3.1 Trawlvision

Project Full Title: Developing computer vision methodologies for real-time processing of in-trawl video recordings

Project Timeframe: September 2023 – September 2025

Institution(s): DTU Aqua

Contact person: Ercan Avsar, erca@aqua.dtu.dk;

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The project utilizes recent advancements in camera technology to furnish fishermen with immediate insights into the fish caught in their gear. This enables them to make well-informed decisions in real-time, relying on quantitative data, regarding whether to start, halt, or continue fishing. This objective will be realized through the utilization of computer vision techniques assisted by artificial intelligence. Videos captured by underwater cameras within the trawl will undergo processing by deep learning models, with a focus on developing lighter models to achieve real-time processing speeds. A user-friendly interface will be crafted to convey catch composition information to fishermen, empowering them to make on-the-spot decisions regarding their trawling activities. Until now, exhaustive experiments have been carried on edge hardware with state-of-the-art object detection models to test whether real-time processing is achievable. It has been shown that this is possible achieve real-time processing by skipping some intermediate frames. In addition, the first version of the graphical user interface has been developed (Figure 9.7).

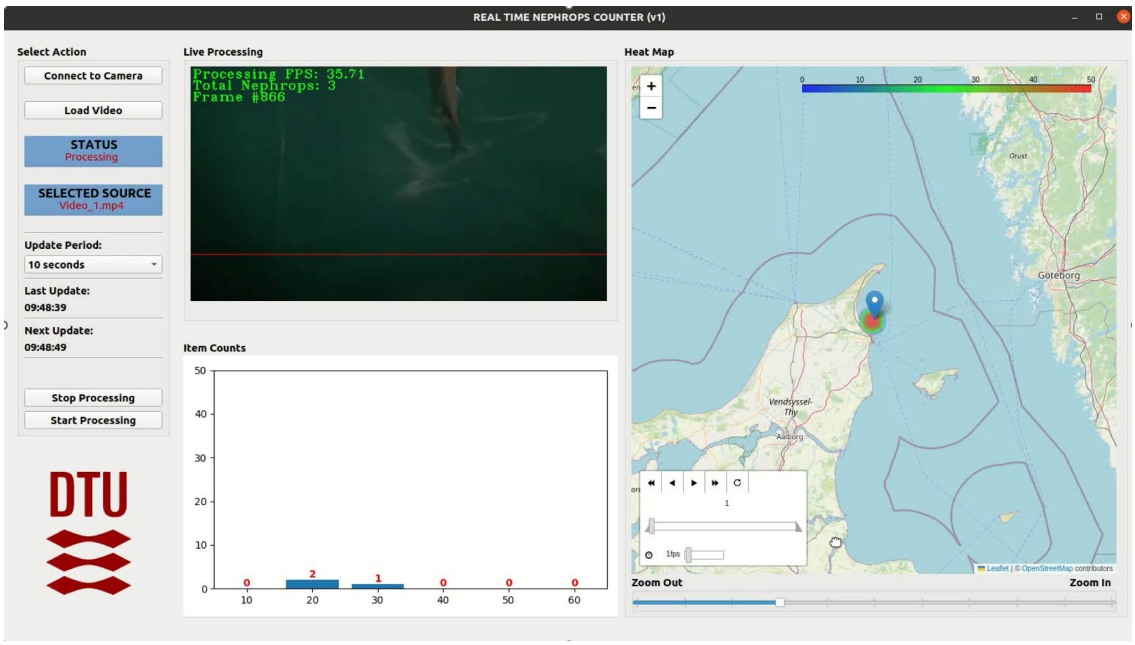


Figure 9.7. Screenshot of the graphical user interface

9.5.3.2 Observing and quantifying fish behaviour in relation to active fishing gear

Project Full Title: Observing and quantifying fish behaviour in relation to active fishing gear

Project Timeframe: May 2022 – November 2025

Institution(s): DTU Aqua, IMR (Norway)

Contact person: Junita D. Karlsen, juka@aqua.dtu.dk

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Animal behaviour is one of few main components that are decisive for the catch efficiency and selectivity of commercial fishing gears. This project takes advantage of recent technological developments in split-beam acoustics to provide a new quantitative way to study animal behaviour in relation to fishing gear. This technology can operate under operational conditions with low light levels, i.e. at depth or at night, or in turbid waters where optic observations contain little or no information. From data collected in the laboratory or during sea trials, tracks of individual gadoid fish, northern prawn (*Pandalus borealis*), and Antarctic krill (*Euphausia superba*) are being identified and quantified (Figure 9.8). From the tracks, the response of fish to simulated trawl stimuli and crustacean behaviour in the trawl mouth will be described. The activities in the project are part of a larger effort in DTU Aqua to investigate the optimal use of complementary observation technologies (optics, multibeam sonar, and split-beam acoustics) to observe animal behaviour in the capture process of active and passive gears and are linked to activities in the finished EMFF project Selekt, and new EMFAF projects TechCare and Sonus. The results of the project have the potential to support the development of more sustainable fishing gear and practices.

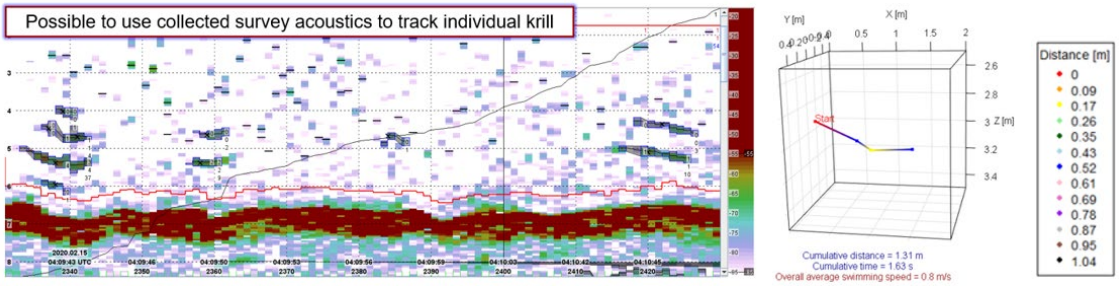


Figure 9.8. Tracking Antarctic krill in the trawl mouth of a midwater trawl. Left: Echogram showing krill tracks. Right: An example of a corrected track of an individual krill and associated colour legend for distance. From the track, variables such as distance, swimming speed and direction can be extracted for description of behaviour in the trawl.

9.5.3.3 Network: BeFish Network

Network Full Title: Network on Behaviour in Relation to Fishing Gear

Network Timeframe: March-2023 –

Institution(s): DTU Aqua (Denmark, convener), ANIFPO/NIFPO (UK), AZTI (Spain), BIM (Ireland), ICAR-CIFT (India), IFREMER (France), ILVO (Belgium), IMR (Norway), ILVO (Belgium), Marine Lab (UK), MFRI (Iceland), Seafish (UK), SLU (Sweden), Thuenen (Germany), Trident Seafoods (USA), University of Exceter (UK).

Contact person: Junita D. Karlsen, juka@aqua.dtu.dk

Is the network directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The initiative to the international Network on Behaviour in Relation to Fishing Gears was taken at the 2023 ICES-FAO WGFTFB meeting in Kochi, India. The main aim of the network is to focus on how to overcome barriers preventing researchers from making substantial progress in understanding the responses of animals to fishing gear in the capture process to develop efficient and sustainable fishing gear. Other aims are to share knowledge and experiences, conduct supplementary and prevent replicating studies, and establish future research collaborations on the topic. The network meets online bimonthly for discussions. Resources are provided to the network through invited talks by e.g., researchers from other relevant research areas (Figure 9.9). Invited talk on the lateral line organ by Dr. Joachim Mogdans, University of Bonn, Germany in

the BeFish Network on the 27th of March 2024.) and representatives from the fishing industry, minutes from the meetings and sharing of relevant literature.

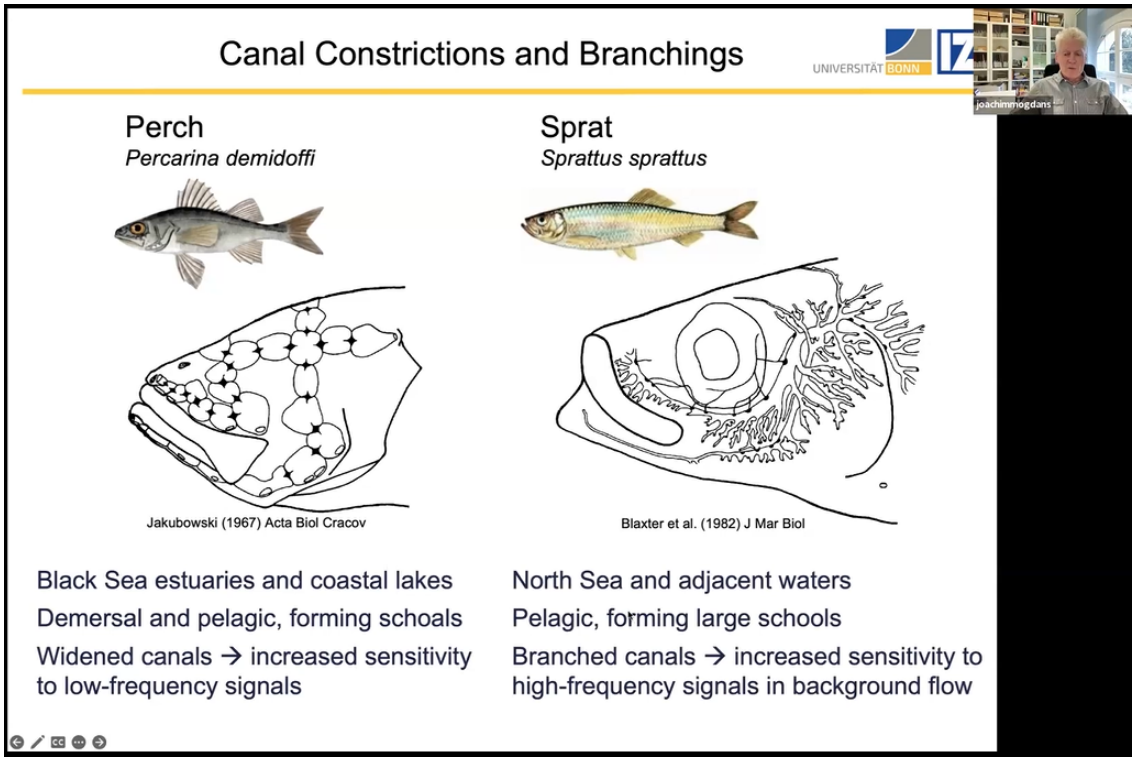


Figure 9.9. Invited talk on the lateral line organ by Dr. Joachim Mogdans, University of Bonn, Germany in the BeFish Network on the 27th of March 2024.

9.5.3.4 TechCare

Project Full Title: Technological Advancements for Carbon-footprint Reduction in the northern shrimp fishery

Project Timeframe: November-2023 – November-2026

Institution(s): DTU Aqua

Contact person: Tiago Veiga-Malta, timat@aqua.dtu.dk

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The primary objective of this new project is to enhance the ecological sustainability of Danish demersal trawl fisheries. This will be achieved by minimizing both the carbon footprint and the seabed impacts associated with these fisheries. This goal will be realized through the adaptation of various components of the trawl gear and the evaluation of novel approaches to the catching process using cutting edge fishing equipment and advanced catch monitoring systems. The Northern shrimp (*Pandalus borealis*) fishery serves as a pertinent case study due to its considerable fuel consumption per catch, particularly problematic given the current escalation in fuel prices. To inform potential redesigns or modifications of the trawl to reduce hydrodynamic drag and, consequently, fuel consumption, the capture mechanism of shrimp is investigated. The first observations during fishing have been collected using split-beam acoustics (Figure 9.10). Observing Northern shrimp (Pandalus borealis) distribution to understand the capture process by a shrimp trawl. Top: experimental set-up with split-beam acoustics. Bottom:

echogram of the first data collected in narrowband with a 120 kHz 18-degree transducer. The smaller dots are shrimp while the stripes in the bottom half are fish bycatch. (contact person: Junita D. Karlsen, juka@aqua.dtu.dk)). The project's methodologies and advancements transcend the shrimp fishery and are directly transposable to other demersal trawl fisheries.

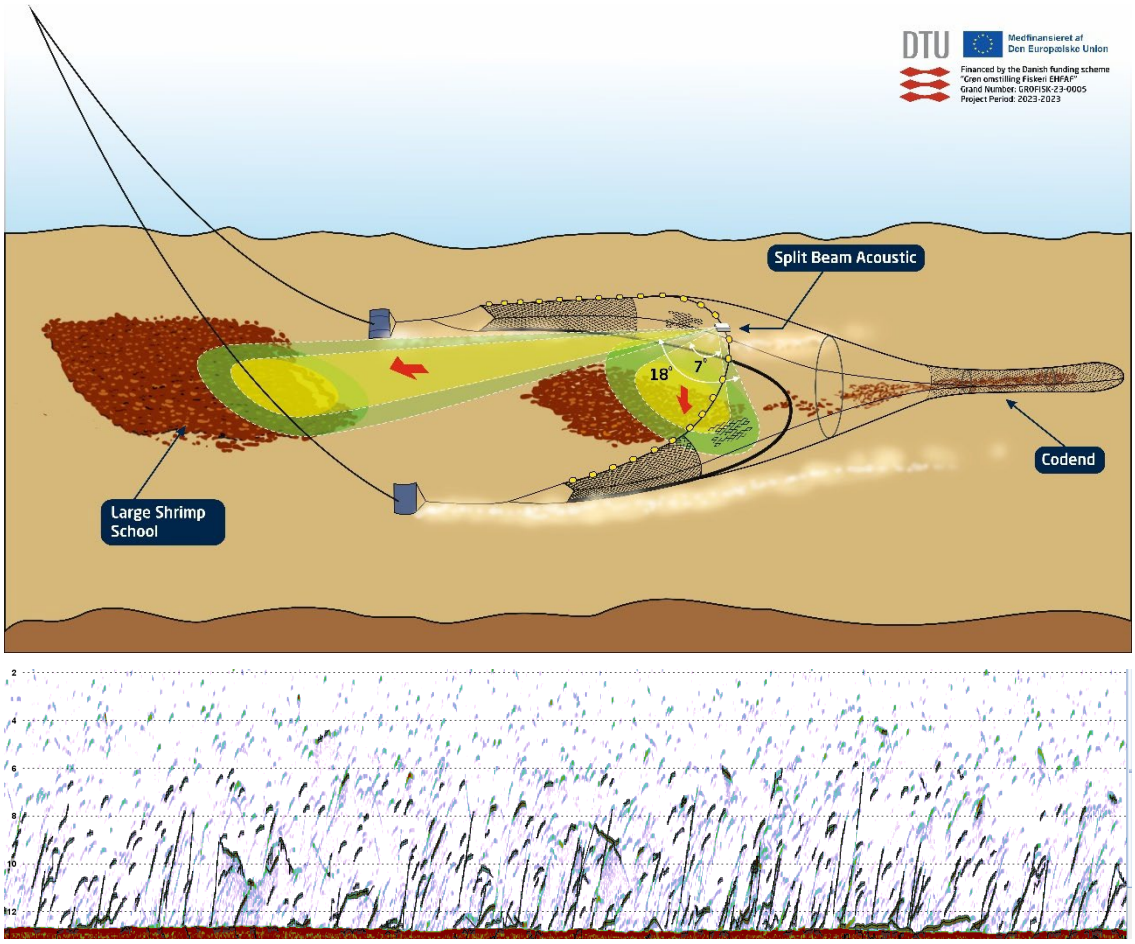


Figure 9.10. Observing Northern shrimp (Pandalus borealis) distribution to understand the capture process by a shrimp trawl. Top: experimental set-up with split-beam acoustics. Bottom: echogram of the first data collected in narrowband with a 120 kHz 18-degree transducer. The smaller dots are shrimp while the stripes in the bottom half are fish bycatch. (contact person: Junita D. Karlsen, juka@aqua.dtu.dk)

9.5.3.5 Dsolve

Project Full Title: Centre for the development of biodegradable plastics for marine applications – innovative fisheries and aquaculture

Project Timeframe: November 2020 – September 2028

Institution(s): National Institute of Aquatic Resources (DTU Aqua), The Arctic University of Norway (coordinator), SINTEF Industry (SINTEF AS), Norway, SINTEF Ocean AS, Norway, Thünen-Institute of Baltic Sea Fisheries, Germany, University of Split, Croatia

Contact person: Ludvig Ahm Krag, lak@aqua.dtu.dk

Link(s): https://dsolve-sfi.no/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? Yes

Summary: The main working hypothesis for SFI Biodegradable plastics is that the problems associated with marine plastic litter caused by the fishery and aquaculture sectors can be significantly reduced if traditional plastics in these sectors are replaced with new biodegradable materials.

The goal of SFI is to develop technologies and new products, improve the governance framework, and foster innovations that enable the plastic value chains to become more circular and resource efficient. This will reduce the carbon and greenhouse gas footprints to be more in line with climate, energy, and sustainable development goals (UN SDG 9, 12, 14).

Specifically, DTU Aqua will test biodegradation of gillnets and twines (PBSAT as test and PA as control) in the gill-net fishery for cod and plaice in the Skagerrak.

9.5.3.6 HydroLift

Project Full Title: Using hydrodynamics to develop low impact selective fishing gears

Project Timeframe: September 2023 – September 2025

Institution(s): DTU Aqua

Contact person: Barry O'Neill, barone@aqua.dtu.dk; Valentina Melli, vmel@aqua.dtu.dk

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This project investigates the use of hydrodynamic turbulence to lift benthic species into the path of a trawl net. The principles of this approach have already been demonstrated in the Danish sea star fishery. Computational Fluid Dynamic analyses and particle tracking models were developed to investigate how design parameters, such as beam size, shape, and height off the seabed, alter the wake hydrodynamics (Figure 9.11). Computational Fluid Dynamic simulation showing the turbulent wake behind a circular-shaped beam towed at a height above seabed equal to 0.75 times its diameter.). The first case-study address is the sea star trawl fishery in the Limfjorden (Denmark) were optimization experimental trials with industry are ongoing to maximize catch efficiency of the target species (star fish) and minimize the bycatch of blue mussels (*Mytilus edulis*) on different types of fishing grounds (e.g. mussel beds, cockle beds).

Future work will explore the potential of using this approach in some of the important European mixed demersal trawl fisheries (e.g. shrimp, flatfish) and carry out sea trials with behaviour observations to assess the selective and environmental performance of the new gear design in these fisheries.

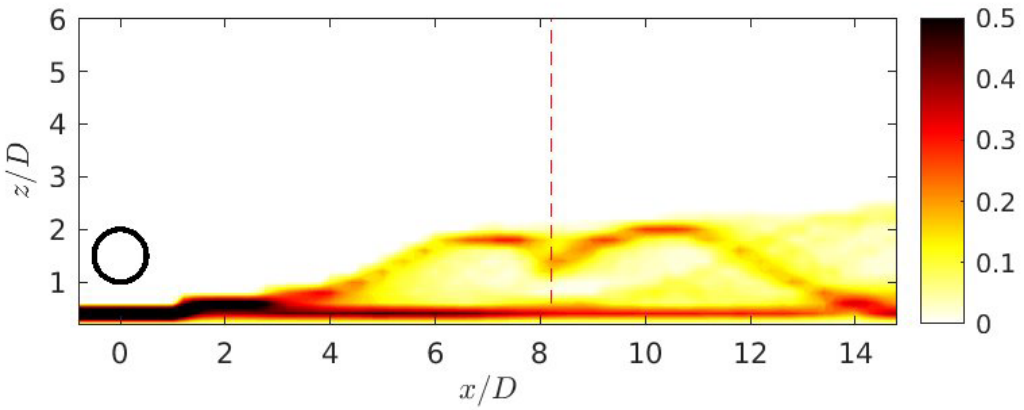


Figure 9.11. Computational Fluid Dynamic simulation showing the turbulent wake behind a circular-shaped beam towed at a height above seabed equal to 0.75 times its diameter.

9.5.3.7 RightFish

Project Full Title: Reducing environmental impact and greenhouse gas emissions in commercial fisheries.

Project Timeframe: 01/11/2022 - 01/11/2025

Institution(s): DTU Aqua (coordinator), SINTEF OCEAN, National Research Council of Italy, Hampiðjan, Iceland

Contact person: Barry O'Neill, barone@aqua.dtu.dk

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: RightFish will develop generic methodologies that will improve our ability to design and develop low impact and fuel efficient towed fishing gears.

It will investigate the criteria for small scale modelling in flume tanks that incorporate the contact forces associated with fishing gears being towed over the seabed. This will aid the design and development of gears that are more fuel-efficient, disturb fewer carbon-rich sediments and penetrate less into the seabed. These methodologies will be applied in two case studies, which characterise European demersal trawl fisheries (i) a twin trawl on muddy sediment and (ii) a single trawl on sandy sediment. The environmental and economic benefits that can be achieved will be assessed, taking into account the physical impact to the seabed, the reduction of fuel and greenhouse gas emissions, and the likelihood of increased fishing opportunities, improved market access and higher prices.

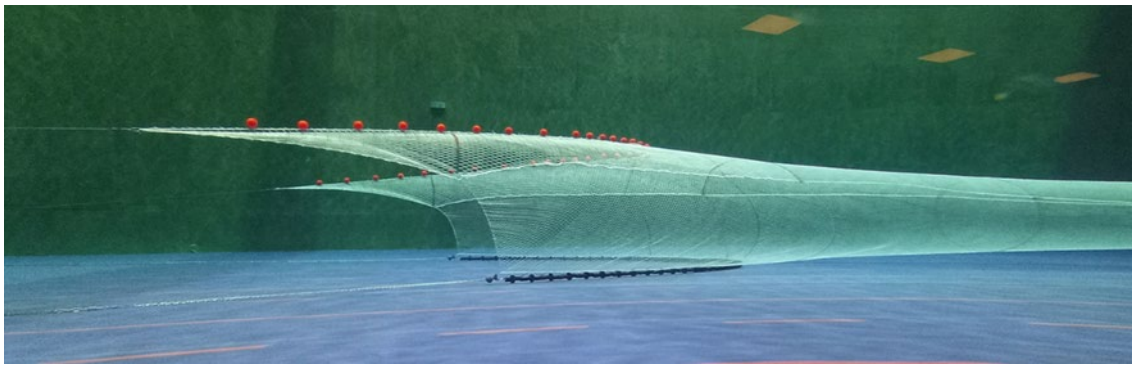


Figure 9.12. Example of fuel-efficient gear during development phase in the Flumetank in Hirtshals.

9.5.3.8 EveryFish

Project Full Title: Innovative technological solutions for fully automated catch recording and reporting

Project Timeframe: 01/01/2023 - 31/12/2026

Institution(s): SINTEF OCEAN (coordinator), DTU Aqua, Institute of Marine Research, Norwegian Directorate of Fisheries, AZTI, Melbu Systems AS, Cukurova University, ILVO, Wageningen University, Anchor Lab, Wageningen Research, ASSIST Software, Datafish Technology Solutions S.L., University of East Anglia, CEFAS, University of St Andrews.

Contact person: Jordan Feekings, jpfe@aqua.dtu.dk

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: EVERYFISH is an EU-funded project led by SINTEF Ocean, where 17 partners from 8 different countries are cooperating to develop the next generation of technological solutions for automatic registration and reporting of catch data from fishing vessels. Automated catch recording and reporting will be tested on board European fishing vessels, and these data will then be used to develop innovative governance strategies that make use of the automatically reported catch data.

In EVERYFISH, DTU aims to develop and test, in a real-world application, how a digitalised control and enforcement, namely EM, can facilitate a more simplified management framework while at the same time facilitating an increase in compliance with the technical conservation measures. Specifically, DTU will

- review existing technical measures regulation within the EU with the objective of understanding the reasons to why different regulation are in place, and under a FDF what aspects can be removed without compromising the sustainability of fish stocks.
- Undertake a pilot study where participating vessels with be allowed to use gears they define and where aspects of the technical measures are removed (e.g. technical specification of gears).
- Provide feedback to fishers on how their quotas are being utilised so they can actively adapt their fishery to avoid unwanted catches.

9.5.3.9 GreatDane

Project Full Title: Development and value optimisation of a Danish fishery for greater weever (*Trachinus draco*)

Project Timeframe: 01/01/2023 - 31/12/2026

Institution(s): DTU Aqua (coordinator), DFPO, Danske Fiskeauktioner A/S

Contact person: Jordan Feekings, jpfe@aqua.dtu.dk

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Greater weever (*Trachinus draco*) is a demersal fish species that is found in shallow (1-30 m) coastal waters throughout Europe. It is typically found on sandy, muddy or gravelly bottoms, and can grow to a maximum length of 50 cm (common length=25 cm). Despite being of commercial interest for human consumption and considered a delicacy in some European countries, the majority of landings (>90 %) in Denmark are sold for industrial purposes (i.e. fishmeal). Only small quantities (10-40 tonnes annually) are sold for human consumption. The limited landings sold for human consumption in Denmark is largely due to the very low retention of this relatively small fish in the mesh sizes currently legislated for demersal trawling in Danish waters. Consequently, the seabed impact and CO2 consumption in the fishery is much higher than necessary. In recent years, there has been a growing interest in targeting greater weever for human consumption, both from the fishers and fish processors. An initial fishery conducted in collaboration with the commercial fishing vessel FN 267 Emilie, Fiskeristyrelsen and DTU Aqua in April 2019 showed that greater weever can be targeted commercially with very low unwanted bycatch in the Kattegat.

This project aims to optimize the efficiency, sustainability and economic performance of the commercial fishery for greater weever. This will be achieved by ensuring the necessary management foundation is established to ensure the species is harvested sustainably, the fishing gears employed are tailored to catching the appropriate sizes of greater weever efficiently without high levels of bycatch, and by ensuring that a large part of the landings are processed for human consumption rather than for industrial purposes. Improving the resource efficiency of a fishery in such a manner aims to ensure the long-term sustainability within the fishery resulting in long-term green growth within Denmark. This will not only increase the first sales value of catches within the Kattegat but also provide the Danish Kattegat fleet with an alternative to fishing stocks that are overexploited. The subsequent establishment of a greater weever market for human consumption will also increase income to Danish exporters.

9.5.4 Future projects

9.5.4.1 Marine Beacon

Project Full Title: Monitoring and elimination of bycatch of endangered and conserved species in the NE and high seas Atlantic region

Project Timeframe: 01/01/2024 – 01/01/2028

Institution(s): Marine Institute (Ireland, Project coordinator), DTU Aqua (Denmark), Sustainable Fisheries Greenland (Greenland), Ifremer (France), Marport (France), IEO-CSIC (Spain), AZTI (Spain), UAc (Portugal), IMAR (Portugal), UCC (UK)

The consortium is broader but these are the active partners in terms of development of bycatch mitigation solutions.
Contact person: Valentina Melli, vmel@aqua.dtu.dk; Ludvig Krag, lak@aqua.dtu.dk

Funding secured?: Y

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: MARINE BEACON is an EU funded Research and Innovation project, led by the Marine Institute in Ireland (coordinator: Julia Calderwood; Julia.Calderwood@Marine.ie) aiming to address the impact of bycatch on the decline of marine biodiversity by producing the knowledge and tools to effectively reduce the bycatch and subsequent mortality of ETPS within European waters and beyond.

Within MARINE BEACON, DTU Aqua leads the Work Package dedicated to the development of solutions to mitigate the bycatch of ETPS at all level of interaction with fisheries:

1. Encounter between ETPS and fisheries:

Assessment of the suitability of both Marine Protected Areas (MPAs) and fishery closures (static and dynamic) to avoid bycatch of PETS while balancing the sustainable target catch. Case-studies in relation to seabirds and passive gears fisheries in Ireland; elasmobranchs/sea turtles and longline fisheries in the Azores; elasmobranchs and tropical tuna purse-seine in the ABNJ).

2. Prevention of contact and/or interaction with the fishing gear once encountered

Development of different repellent technologies, including visual stimulants aimed at increasing the visibility of fishing gears (e.g. coloured nets, LED lights); intelligent acoustic pingers that activate upon detection of dolphins; and magnetic repellents to repel elasmobranchs from static fishing gears.

3. Technologies that allow for the safe release of PETS after contact with the gear

Different technologies based on the risk status of the PET and frequency of encounter. An excluder concept for large PETS (e.g. Greenland shark); a prototype emergency release system for air-breathing PETS and an active selectivity trawl concept for frequently encountered PETS in trawl fisheries (e.g. elasmobranchs). The latter two technologies will be based on automatic species detection through real-time trawl cameras.

4. Handling and release of PETS that are brought on board the vessel

Post-release survival assessments following best practices and using specific bycatch releasing devices e.g. novel at-depth release device developed for deep-water elasmobranchs or new devices installed on the fishing deck of tuna purse-seiners.

9.5.4.2 OptiFish

Project Full Title: Optimisation of digital catch monitoring and reporting in European fisheries.

Project Timeframe: 01/02/2024 - 31/01/2028

Institution(s): ILVO (coordinator), DTU Aqua, Norwegian Directorate of Fisheries, AZTI, Cukurova University, SINTEF OCEAN, Wageningen University, Anchor Lab, Wageningen Research, BENCO Baltic, SCiO, Foodscale Hub, Efice, Justervesenet, VCU Robotics, DPPO, DFPO, Zunibal.

Contact person: Jordan Feekings, jpfe@aqua.dtu.dk

Funding secured?: Y

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: OptiFish aims to develop, test, and validate technologies that will improve onboard monitoring of catch volumes and fish health, enabling fishers to improve the sustainability of their operations, and better meet control requirements. More specifically, the technologies investigated during the project will enable automated species recognition based on AI and computer vision to reduce discards, unreported landings, and unreported fishing activities, establishing a fisheries control and enforcement system fit for the digital age.

DTU Aqua is scientific co-lead for the project and involved in the following activities:

Lead: T2.1.1 Reviewing state-of-the-art technologies; T2.3 Catch reporting technologies; T2.3.1 Collection of gold-standard datasets; T2.3.3 Rapid DNA-based species identification; WP3 Data Collection and Validation in European Fisheries Pilot Studies; T3.1 Catch handling facilities: Pumping; T3.3 Catch handling facilities: Sorting table

Participate: T2.1 Hardware and software requirements, T2.2 Technologies for improved image quality, T2.3.2 EM-based species identification and sizing, T2.4 Fish health and quality assessment, T2.5 Improved monitoring of fishing activities; T3.4 Catch handling facilities Sorting deck; T4.1 Requirements specification Data management framework and system architectures; T5.1 Multi-Actor Co-creation Labs (MALs), T5.2 Capacity building and training, T5.3 Policy and legislative framework reform for closing IUU loopholes.

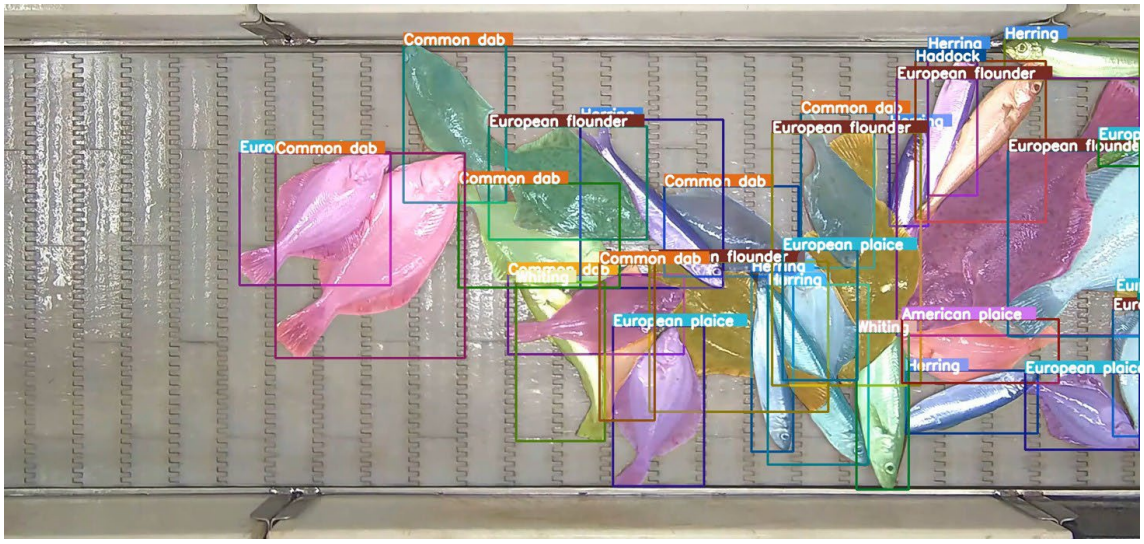


Figure 9.13. Example of recent developments in terms of automated species identification on a sorting belt, with overlapping between catch items.

9.6 United Kingdom (England)

9.6.1 Contact person

- Samantha Stott, CEFAS, samantha.stott@cefas.gov.uk

9.6.2 Summary

- England conducted several studies aiming at improving selectivity and reducing by-catch on marine mammal and birds. The focus of the research was:
- Understanding and improving of trawl selectivity:
    - Modifying the Sumwing trawl to be used on hard ground.
    - Providing an opportunity for a group of skippers working in the English north-east Nephrops (N. norvegicus) trawl fishery to 'road test' preferred trawl options, selected from a 'show room' of designs that have demonstrated potential to reduce unwanted catches in limited scientific trials.
- Reduction of unwanted by-catches of marine mammals and birds:
    - Understanding the efficacy of above-water deterrents in the context of an operational fishery.
    - Develop fisher-led approaches to monitor and mitigate PETS bycatch

9.6.3 Projects

9.6.3.1 FARNTASTIC

Project Full Title: Road test selective trawls in the Farn Deeps Nephrops fishery

Project Timeframe: November 2022 – May 2024

Institution(s): Cefas; Department for Environment, Food and Rural Affairs (Defra), Boris Nets, Seafish

Contact person: Samantha Stott, CEFAS, samantha.stott@cefas.gov.uk

Link(s): Home - Cefas (Centre for Environment, Fisheries and Aquaculture Science); Department for Environment, Food & Rural Affairs - GOV.UK (www.gov.uk); Boris Nets | Aquaculture, Safety, Sports, Bird Control; Learn about Seafish and what we do — Seafish

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project brings together fishing industry, technologies, and science partners to test and gain confidence in using more selective trawls in English northeast Nephrops (N. norvegicus) trawl fishery. This a project was funded by the Department for Environment, Food and Rural Affairs (Defra).

In this study, eight skippers led in selecting and testing the trawl designs under commercial conditions for a sufficient time to gain experience and confidence in the designs. The tested designs included coverless trawls, separator trawls and large escape panels in the trawl. The skippers were able to test the performance of the design for 15 months, covering two fishing seasons. Furthermore, skippers were given the opportunity to record information on the performance of the trawls which will be analysed to evaluate whether the trawls have demonstrated a reduction in unwanted catches.

9.6.3.2 Modifying the Sumwing hydrofoil for fishing on hard ground (Rockwing)

Project Full Title: Modifying the Sumwing hydrofoil for fishing on hard ground

Project Timeframe: 2023 – 2024

Institution(s): The Western Fish Producers' Organisation

Contact person: Chloe North, WFPO, chloe@western.fish

Link(s): WFPO (western.fish)

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: We will adapt the Sumwing trawl so it can used on hard ground. The Sumwing is a new beam trawl that uses a hydrofoil wing instead of the traditional cylindrical beam. The wing uses hydrodynamics to fly just above the seabed, rather than using weight to stay on the seabed. This has a dual benefit of reducing fuel consumption and seabed impact. The SW beam trawl industry trialled this gear in 2021 (Seafish report SR761). The Sumwing currently can only be used with 'open' gear and on soft, clean ground. However, the majority of UK beamers fish on hard, rocky, undulating ground (hard ground). Therefore, the Sumwing has limited scope for adoption and needs to be redesigned to meet the needs of the UK beam trawl fleet. The SW industry have collaborated with the Dutch inventor of the Sumwing to discuss the redesign. This project will redesign, build and carry out sea trials to test whether the hydrodynamics of the modified Sumwing (Rockwing) operate effectively over hard ground. The redesigned Sumwing (Rockwing) will be tested against traditional beam trawl gear to assess fuel efficiency and seabed contact. The trial will open the Sumwing technology to many more vessels in the UK (The original Sumwing achieved 40% reduction in fuel consumption).

9.6.3.3 Fishtek Marine

Project Full Title: Above-water deterrents: mitigating seabird bycatch in set net fisheries

Project Timeframe: November 2022 – May 2023

Institution(s): Fishtek Marine; the Royal Society for the Protection of Birds (RSPB); Seafood And Eat It Processing Ltd; SeaScope Fisheries Research Ltd

Contact person: Fishtek Marine, info@fishtekmarine.com

Link(s): Prevent Bycatch - Sustainable Fishing Gear - Reduce Bycatch (fishtekmarine.com)

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Bycatch in gillnet fisheries is a global conservation issue, costing the life of nearly 400,000 seabirds each year. In the UK, set nets off the UK's coast have been identified as potentially important bycatch hotspots as a key wintering area for great northern divers, black-throated divers and Slavonian grebes – all of conservation concern in the UK. Above-water deterrents have recently been developed as tools to mitigate bycatch of seabirds in set nets. This emerging technology has shown significant promise with regards to deterring diving birds from the proximity of set nets. The efficacy of these devices is limited to preliminary trials conducted in the Baltic Sea. There is a need to understand if these findings could translate into reduced bycatch in an operational fishery.

9.6.3.4 Clean Catch UK

Project Full Title: Clean Catch UK: Joint action to reduce wildlife bycatch

Project Timeframe: Phase 1 – 2019 to 2024, Phase 2 2024 to 2027

Institution(s): Phase 1- funded by Department for Environment, Food and Rural Affairs (Defra), delivered and led by Cefas with partners Mindfully Wired Communications and Arribada.

Phase 2 - funded by Department for Environment, Food and Rural Affairs (Defra), delivered through a consortium of partners including Cefas, Arribada, Mindfully Wired Communication, Zoological Society London and MMO consulting limited

Contact person: Joanna Murray, Joanna.murray@cefas.gov.uk

Link(s): Home - Cefas (Centre for Environment, Fisheries and Aquaculture Science); Department for Environment, Food & Rural Affairs - GOV.UK (www.gov.uk); Clean Catch UK - ME6023 (defra.gov.uk)

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Since 2019, the Clean Catch UK (CCUK) programme has set out to develop fisher-led approaches to monitor and mitigate PETS bycatch. Research has been designed to monitor PETS populations, monitor PETS bycatch, and develop PETS bycatch mitigation tools. Specifically, the following questions are addressed:

Monitoring of abundance and distribution

- Passive acoustic monitoring – Can monitoring of underwater sound be used as an effective and reliable method for continuous monitoring of cetaceans in an area of higher bycatch risk?

Monitoring of bycatches

- Self-reporting – What tools are available for industry self-reporting, and can they be used to generate reliable data on PETS bycatch?
- Remote Electronic Monitoring (REM) – Can REM be used to develop protocols for PETS bycatch monitoring, to build wildlife bycatch image libraries to train artificial intelligence (AI) solutions for video processing, and to validate self-reported data?

Mitigation of bycatches

- How do cetacean pinger deterrents perform for reducing bycatch of common dolphins in a Southwest net fishery?

Can passive acoustic deterrents that are co-designed by fishers offer an effective cetacean bycatch mitigation?

9.7 France (Ifremer)

9.7.1 Contact person

- Faillettaz, Robin, Ifremer, robin.faillettaz@ifremer.fr

9.7.2 Summary

Most of the fish technology work conducted in France remains done within the Fishing Technology lab in Ifremer Lorient. While the major focus remains on trawl fisheries to reduce their impact and maintain sustainability (projects Marine Beacon, ESCAPE), the relative importance of passive gears development (projects BioBAIT, Poulpe Fiction) and monitoring of both bycatch (project Marine Beacon) and ALDFG (project CARAMBAR) is increasing in the recent projects.

The application of artificial intelligence is also becoming a key component of most projects (Marine Beacon (the 3rd season of the project Game of Trawls), LEARN that focuses on fish behavior and ESCAPE, on fish escapement in trawls).

9.7.3 Projects

9.7.3.1 Marine Beacon

Project Full Title: Acquisition of knowledge on the dynamics and catchability of octopus in Southern Brittany in order to define a management plan

Project Timeframe: May 2022 – December 2024

Institution(s): Project coordinator: Marine Institute (MI); partners involved with Ifremer related tasks: Ifremer, DTU Aqua, EV ILVO, AZTI, MI, Atlantic Technological University, Universidade dos Acores

Contact person: Robin FAILLETTAZ, Ifremer, robin.faillettaz@ifremer.fr

Link(s): https://marinebeacon.eu/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Funded by the EU Horizon Europe Programme, Marine Beacon is a €8.8 million, 4.5-year project that aims to address gaps in our current understanding of how fisheries bycatch impacts protected, endangered and threatened species. The project will work with fisheries, policy and conservation stakeholders to develop and test innovative, tools and techniques for better monitoring of these important species and mitigating risks of bycatch, to ensure healthier seas and more sustainable fisheries. The project just started (administratively in February 2024). Ifremer is involved in three WP, which aim at pursuing the development of the Game of Trawls system and data sharing for AI applications in fisheries, in collaboration with other European labs, to better detect PETS and select catch in real-time.

9.7.3.2 Poulpe Fiction

Project Full Title: Acquisition de connaissance sur la dynamique et la capturabilité du poulpe spécifiquement en Bretagne Sud en vue de la mise en place d'un plan de gestion

Project Timeframe: May 2022 – December 2024

Institution(s): Regional and departmental fisheries boards (CRPM and CDPM), National Museum of Natural History (MNHN), Ifremer

Contact person: Sonia MEHAULT, Ifremer, sonia.mehault@ifremer.fr

Link(s): https://www.cdpmem56.fr/poulpefiction/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The Poulpe Fiction project aims to gain a better understanding of octopus population dynamics and catchability, in order to put in place sustainable management measures for the fishery. Today, octopus fishing is a major outlet for the fisheries of Southern Brittany. Management measures therefore need to be put in place quickly to regulate this fishery and ensure its sustainability. Management scenarios will be studied in the light of the biological and

technological data collected as part of the project. Initially, a protocol will be deployed to gain a better understanding of the species' life cycle. Next, a sampling plan will be implemented to understand the catchability of the species by type of gear and by sector depending on the season. 2 auctions in southern Brittany will be sampled to collect data on the sexual maturity, biometry and age of the individuals caught. Finally, a benchmark of the management measures adopted without other octopus fisheries in the Atlantic, including Spain and Portugal, will be carried out and consultations will be held with Breton fishermen in order to put in place new management measures.

9.7.3.3 BAITFISH biobAIt

Project Full Title: Assessment of sustainable baits for passive fishing gears through automatic fish behavior recognition

Project Timeframe: January 2022 – January 2024

Institution(s): IFREMER

Contact person: Alexa ABANGAN, Ifremer, alexa.abangan@ifremer.fr

Link(s): NA

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: As part of a PhD and following the BAITFISH project, an experimental biodegradable biopolymer-based artificial baits (bio-bait) has been developed to target black seabreams (*Spondyliosoma cantharus*) in the Bay of Biscay. Our objectives were to develop a bait made with lower concentrations of valuable marine resources (here, cockles) that lasts longer than raw bait and assess their efficiency using automatic data processing methods. We assessed the bio-bait efficiency through continuous 9-hour observations using a simple observation set-up (Figure 9.14 ab), recording fish movement around the bio-bait (Figure 9.14 c). We used machine and deep learning models for tracking and classifying fish behavior by quantifying behavioural metrics (Figure 9.14 d) from video footage. Although bio-baits initially attracted seabreams less effectively than natural baits, they maintained higher activity levels after natural baits were depleted, showing promise for improving bio-baits and automating fish behavior recognition. Future research should focus on enhancing bio-bait attractiveness through diversified amino acids and optimized bait shapes, as well as refining automatic behavior classifiers to streamline the behavioural analysis of target species in other conditions.

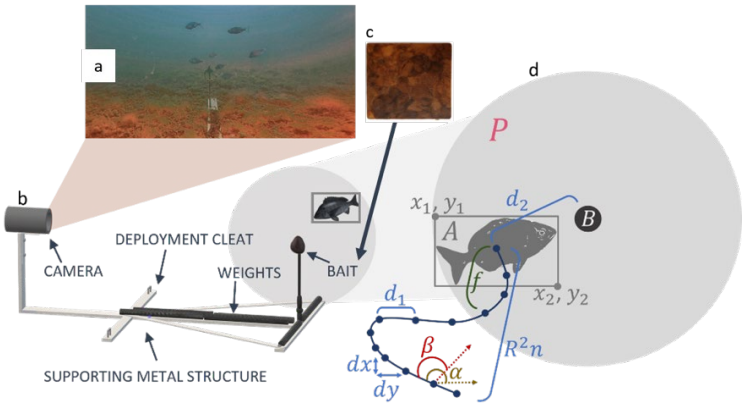


Figure 9.14. Overview of in situ set-up and behavioural metrics.

9.7.3.4 LEARN

Project Full Title: Assessment of the phototactic behavior of European seabass (*Dicentrarchus labrax*) to infrared light.

Project Timeframe: October 2023 – June 2024

Institution(s): IFREMER

Contact person: Alexa ABANGAN, Ifremer, alexa.abangan@ifremer.fr

Link(s): NA

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: As part of the PhD project LEARN, the response of European seabass (*Dicentrarchus labrax*) towards infrared light was tested to discard any potential bias when using infrared light to study the species' behavior. Experiments were conducted in a covered basin through alternating sequences of infrared (IR) illumination (IR) and dark condition. Swimming trajectories were extracted from hydroacoustic videos and processed through a tracking software, to extract quantitative behavioral metrics were quantified from the seabass movement patterns such as speed and directional headings. Seabass showed no preference nor deterrence towards IR light, supporting the use of infrared light as an alternative to visible light for monitoring unbiased seabass behavior.

9.7.3.5 ESCAPE

Project Full Title: undErStanding and modelling esCapement behAviour of fish sPeciEs in fishing gearS

Project Timeframe: Oct 2023 – Oct 2027

Institution(s): Ifremer, MNHN, Université Libre de Bruxelles,

Contact person: Marianne ROBERT, Ifremer, marianne.robert@ifremer.fr

Summary: Knowledge of animal behavior is a key element in understanding the capture processes of fishing gear. This knowledge would enable the design of selective fishing devices and gear to avoid unwanted catches. By combining fishing gear technology, artificial intelligence,

behavioural concepts and functional ecology, the ESCAPE project aims to quantify, understand and model the various stages of fish capture and escape processes in active (trawl) and passive (trap) fishing gear. The first objective is to identify the underlying behavioural rules and their morphological and functional determinants at individual and specific levels. The behavioural rules will be formalized mathematically and tested in a coupled animal-gear modelling framework. This project will provide a tool for predicting and optimizing the selective properties of fishing gear; stepping-stone toward the development of innovative gear for more sustainable exploitation of marine resources. A dedicated cruise has been conducted in June 2023, gathering over 35 hauls recorded with both imagery and multiple cover codends. Imagery and morphological data are being processed, with over 100,000 annotations of fish already done in the codend and extension (Figure 9.15).

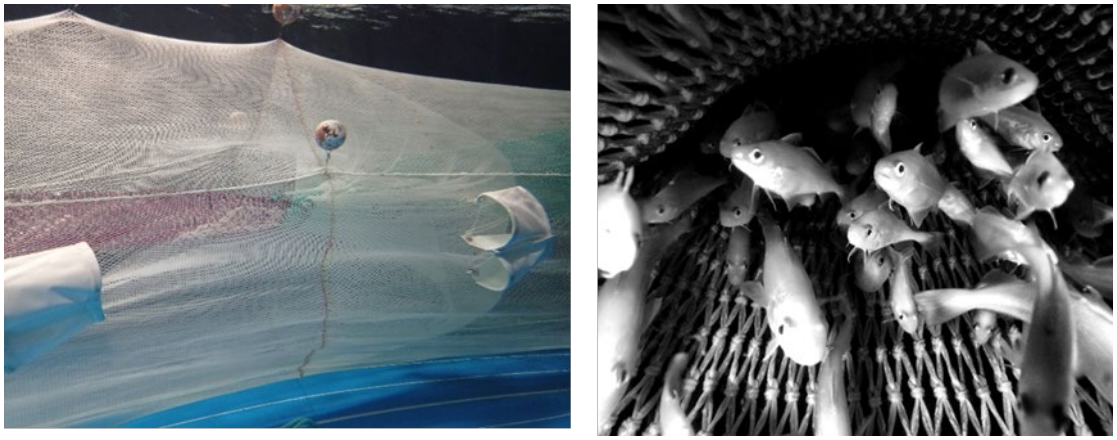


Figure 9.15. Testing the codend cover kites in the flume tank (a) and example of the in situ imagery collected using infrared lighting.

9.7.4 Future projects and Ideas

9.7.4.1 CARAMBAR

Project Full Title: CARActerisation & Minimisation of fishing gear impacts: the case study of the Bay of Biscay, French Antilles and st PieRre

Estimated Project Timeframe: Mai 2024 – April 2027

Institution(s): Ifremer – Fishing Gear Technology and Biology lab – Lorient (leader), IRMA, Regional and departmental fisheries boards (CRPM and CDPM), National Museum of Natural History (MNHN), Asso-Mer

Contact person: Dorothée Kopp, Ifremer, dorothee.kopp@ifremer.fr; Sonia Méhault, Ifremer, sonia.mehault@ifremer.fr

Link(s): NA

Collaboration welcome?: Yes

Funding secured?: Yes

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? Yes

Summary: The aim of the CARAMBAR project is to limit the impact of fishing gears. In the first axis of the project, we will work on characterizing and diminishing the impacts of Abandonned Lost and otherwise Discarded Fishing Gear in three different French areas, namely the North of the Bay of Biscay, the Caribbean Sea in Martinique and the North West Atlantic in Saint-Pierre-et-Miquelon. For that purpose, we will use an already existing program of citizen science called Fish & Click (https://fishandclick.ifremer.fr/) that is efficient to report ALDFG on the shore but also perform AUV campaigns to detect lost fishing gears at sea. To minimize the impact of ALDFG, we will work closely with stakeholder to achieve the retrieval of the largest pieces and also develop biodegradable materials to limit ghost fishing. Another axis of the project is to work on the selectivity of fish traps in order to reduce the catch of unwanted small-sized individuals, notably in the Caribbean Sea in Martinique where the trap fishery is dominant.

9.8 Germany

9.8.1 Contact person

Daniel Stepputtis, Thünen Institute of Baltic Sea Fisheries, daniel.stepputtis@thuenen.de

9.8.2 Summary

In Germany, research related to fishing gears was mainly conducted by the Thuenen Institute of Baltic Sea Fisheries (see report from university of Rostock below). The focus of the research in 2023-24 was

- Understanding and improving of trawl selectivity
    - Alternative technologies to mitigate the ecological impact of fishing activities, including reduction of unwanted by-catch of fish species in the brown shrimp fishery through gear modifications (SO819 & 820 cruise, 04/2023)
    - Fundamental research on codend selectivity (SO823 cruise, 06/2023; SO828 cruise 11/2023)
- Reduction of unwanted by-catches of marine mammals and birds in gill nets, incl.
    - modification of gillnets
    - improvement and test of alternative fishing gears

Additionally, the fishing- and survey technology working group of the Thuenen Institute currently working on different technical devices which aim to support fishery in general and fishery technological research in particular. Examples are (see also last years report)

- Open Scientific Measurement Board (OpenSMB; www.opensmb.net), a scientific Open Source data acquisition system to be used in fisheries sciences
- Infrared Fish Observation iFO, an Open Source camera system for 24/7 video surveillance
- HyFiVe (Hydrography on Fishing Vessels), an autonomous acquisition hydrographic measurement system for fisheries research and fishing vessels https://www.thuenen.de/en/institutes/baltic-sea-fisheries/projects/fisheries-and-survey-technology/hyfive-hydrography-on-fishing-vessels

9.8.3 Projects

9.8.3.1 By-catch reduction technologies in the North-Sea brown shrimp fishery: First evaluation of sorting efficiency and practicality of the KingGrid

Project Full Title: NA

Project Timeframe: Undefined

Institution(s): Thünen Institute of Baltic Sea Fisheries, DTU-Aqua (Hirtshals, Denmark)

Contact person: Juan Santos juan.santos@thuenen.de

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Summary: The brown shrimp (*Crangon crangon*) beam-trawl fishery is the most important coastal fishery in Germany. One recurrent issue in the fishery is the bycatch of unwanted fish species. To tackle the problem, German legislation requires fishermen to install either a sorting grid or a sieve-net in their trawls. Although very different from a design point of view, sieve-nets and sorting grids serve to the same purpose: to allow by-catch species to escape from capture before they enter the codend. These two technologies have been proposed decades ago, and its performance in commercial fisheries from different North Sea riparian countries were largely investigated during the EU-Study 98/012 "DISCRAN" (Van Marlen et al., 2001). The DISCRAN project showed that both sieve-nets and sorting grids can potentially deliver a satisfactory catch sorting. However, sorting grids have never been commercially adopted, while the sieve-net became the prevalent bycatch-reduction technology. One explanation for such preference is the soft nature of the sieve-net, which makes it a handy and practical alternative for everyday use. On the other hand, using sorting grids can bring handling and operational challenges, and these challenges have been identified as bottlenecks for the adoption of these technologies in the fishery. However, sieve-nets, like any selection device, have shortcomings:

- The maximum-allowed mesh size of the sieve-nets does not prevent small fish from entering the codend, this poor performance on juvenile fish remains a challenge in the fishery, which usually takes place in nursery areas for quoted species such as dab (*Limanda limanda*), plaice (*Pleuronectes plattessa*) or whiting (*Merlangus merlangus*).
- Sieve-nets are large devices mounted inside the trawl body, therefore difficult to access, evaluate, and repair.
- Sieve-nets are prone to clogging by seaweed and benthic organisms, affecting the catch-sorting efficiency of the device.
- The clearing of the clogged sections of the device at sea is challenging and time-consuming, which compromises economically viable fishing activities. Moreover, clogging of the sieve-net increases drag and fuel consumption, impacting economic viability.

In recent years, the problem of sieve-net blockage has reached a level that challenges the viability of the German fishery, particularly during the summer season when high densities of suspended algae and other benthic material are present in estuarine fishing grounds.

Considering the challenges currently faced in the fishery associated to the use of the sieve-nets, researchers of the Thünen Institute of Baltic Sea Fisheries have re-evaluated the potential of sorting grids as alternative to the prevalent technology. This exercise led to the identification of several advantages of sorting grid technologies over sieve-nets:

- Sorting grids can provide a well-defined and stable selection surface which can lead to a more satisfactory sorting of the catch than the sieve nets.

- Past experiences in the German fisheries revealed that grid systems are less prone to blockage as sieve-nets.
- Sorting grids developed for the fishery are small in size and are often mounted in a very narrow section ahead of the codend. Therefore, and unlike sieve nets, they could be easily retrieved and cleaned from haul to haul in the event of blockages.

Identified those advantages, the Thünen Institute initiated in 2022 a project in collaboration with fishermen to address the need for BRD alternatives in the German fishery. The first experimental fishing trials related to the project took place in German fishing grounds onboard the RV/ Solea (September 2022). The aim was to test the catch efficiency of the mandatory sieve-net and to re-evaluated the performance of steel grid designs developed and / or tested during the DISCRAN project. Results obtained from a paired-gear experiment conducted in German fishing grounds under gentle fishing conditions (low risk of clogging) revealed that, when the sieve-net was used, ~95% of the marketable shrimps (total length ≥ 50 mm) available for the trawl ended up in the codend. However, fishing with the traditional sorting grids lead to unacceptable catch losses of targeted shrimp, and also handling issues during fishing manoeuvres. In summary, the 2022 trials showed once again some of the reasons why the old grids technologies have not been adopted in the fishery. However, our assessment suggested that those issues could be tackled by re-thinking the design of the sorting grids, in particular by considering the specific characteristics and needs of the fishery. This led us to envision a new grid concept for the beam trawl fishery, the so-called **KingGrid**. The KinGrid was developed under an innovative design paradigm sharpened by a multidisciplinary team. The conceptual basis of the KingGrid is based on the following fundamental improvements compared to the old sorting grids tested in the fishery:

Design paradigm: The design of the traditional grids that were developed and tested in the German brown shrimp fishery in the 1990s, especially during the DISCRAN project, were largely inspired by designs developed and applied to other fisheries, for example, the original Nordmore grid from Norwegian shrimp fisheries. This "imitation" approach can limit the potential to tackle specific fishery issues through design. In contrast, the KingGrid is based on a functional, problem-oriented design paradigm. Functional design means that the grid and the different elements that compose it have been designed to serve specific functions, optimized according to the specific characteristics of the fishery and the current issues faced.

Construction material: Another negative aspect of traditional grid designs tested in the fishery is the use of steel as main construction material. Steel grids have been often criticized by its rigid nature and the excess of added weight to the fishing gear. In contrast, the KingGrid concept is mostly made of light and flexible polycarbonate (plastic) material. The functional design, and a smart combination of flexible and rigid components have resulted in a more flexible, robust and considerably lighter grid (polycarbonate has an almost neutral weight in water) than the previous generation of grids.

Montage: Building traditional steel grids is an artisanal activity that requires time, precision, and highly qualified welding skills. This in order to achieve precise and consistent bar spacing, and robustness against deformations. As any other artisanal production, the exact replication of a nominal design will be nearly impossible in practice. The KingGrid adopts a different building philosophy. First, the different elements forming the KingGrid are produced using industrial techniques (therefore replicable and scalable). As a results, the produced components can be considered exact replications. Taking advantage of the functional design applied, the montage of the grid is made following simple instructions of a modular assembly. Therefore, the grid can be mounted by the final user easily and without any particular construction skills required.

Selectivity properties: Once a given species with a given size comes into contact with the grid, it is the space between the bars what largely determines whether the individual will be able to pass

through, or whether it is sorted out of the net. Traditional grids are built with fixed bar-spacing, making it unable to adjust its size-selection properties according to changing scenarios in the fishery. In contrast, the modular assembly of the KingGrid allows adjustments of the bar spacing at ease. This property is desirable to adapt the selective properties of the grid according to management requirements or spatio-temporal changes in the population structures encountered by the trawl.

The first experimental fishing trials with the KingGrid took place in April 2023 onboard FFS "Solea", in the same fishing grounds and similar fishing conditions as the 2022 trials (where the old grids were tested). The 2023 trials were designed to answer two main research questions; is the KingGrid a more suitable option for the shrimp fishery than the old grids? if so, which bar spacing should be used to achieve the best catch sorting? to answer these questions, we designed an experiment that involved testing the KingGrid and traditional steel grids in four different bar spacings: 12, 16, 20 and 24 mm. The results obtained during the cruise are promising. According to our crew onboard, the KingGrid was easier to mount in the trawl and to handle than traditional steel grids. In terms of performance, the catch data shows a consistent and efficient catch sorting, independently of the bar spacing used. Surprisingly, using a bar spacing of only 12 mm did not reduce the catches of marketable shrimps compared to catches expected from a trawl using the sieve-net. On the other hand, using this very narrow bar spacing resulted in very clean catches of shrimp, implying a reduction of bycatch species compared to the bycatch expected when using the sieve-net.

After the positive results obtained onboard the research vessel, the KingGrid was tested in commercial vessel in the fall of 2023. The trials were designed as a trials-error exercise for the fishermen to understand how to operate the new device, and to figure out several modifications which should be applied both in the grid design and the trawl in order to enhance performance and achieve a seamless integration of the grid to the trawl. The new acquired knowledge of the fishermen was transmitted and used to improve the initial KingGrid design. Another lesson learnt during the commercial trial is that a proper montage of a grid system might require some modifications of the trawl, and such modifications may require a case-by-case evaluation in order to achieve a fleet-level adoption of the KingGrid. Therefore, the changes of successful adoption of the KinGrid by the fishery could be significantly improved through a gradual, supervised and collaborative transfer of the technology. For this purpose, the next steps within the KingGrid program will involve a wider testing program of the KingGrid in the commercial fishery. Planed commercial trials should expose the KingGrid to the many sources of variability of the fishing activities, and to challenging commercial conditions where the sieve-net tends to fail, for example in the summer season with high abundance of suspended seaweed.

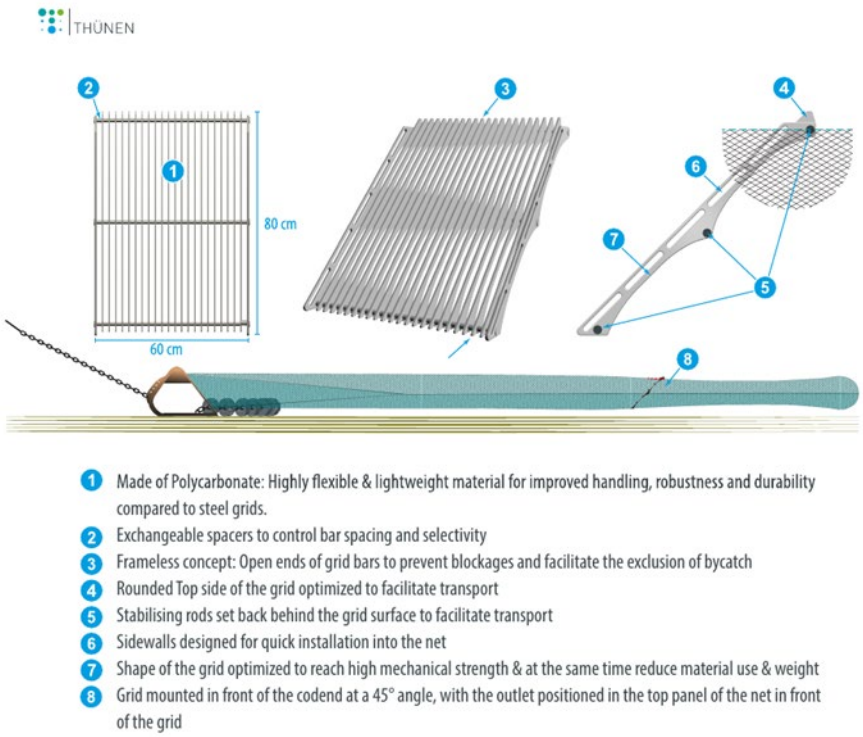


Figure 9.16. Overview and main characteristics of the KingGrid.

9.8.3.2 Exploring the limits of codend selectivity as strategy to reduce the by-catch of cod in flatfish fisheries

Project Full Title: NA

Project Timeframe: Undefined

Institution(s): Thünen Institute of Baltic Sea Fisheries, DTU-Aqua (Hirtshals, Denmark)

Contact person: Juan Santos juan.santos@thuenen.de

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Summary: This research took advantage of previous investigations on the effect of mesh geometry and its variability in the selectivity of demersal fish species in the Baltic Sea. Relevant data for these previous investigations were collected during sea trials onboard RV / "Solea" in Sept. 2021, and June 2022 (see previous FTFB reports for further information). Following the same experimental design and procedures, the last cruise of the series conducted in June 2023 onboard "Solea" was used to investigate how the knowledge acquired during the previous trials could be utilized in fisheries management to improve size and species selectivity in the Baltic Sea. In particular, this investigation explored the limits of codend selectivity as a strategy to reduce the bycatch of cod in flatfish fisheries. For this purpose, the selectivity properties of an experimental codend with mesh size of ~140 mm and fixed square geometry (Fixed Square 140 mm, FS_140) was investigated. The netting of the FS_140 codend was single twine, 3.5 mm Euroline© Premium. To achieve the square geometry, the meshes were fitted to a rigid frame in T0 orientation (traditional diamond-mesh orientation) and OA ~ 90°. Based on theoretical predictions, it was expected that those specifications would lead to very large bycatch reduction of undersized

flatfish (<25 cm, the Minimum Conservation Reference Size for plaice in the Baltic Sea), cod, and other unwanted species. The performance of the FS_140 codend was compared to a standard square-mesh codend, made of Ultracross© knotless netting, 5 mm twine thickness and a mesh size of ~125 mm (Standard Square 125 mm, SS_125). The FS_140 and SS_125 codends were tested one at a time during the cruise, and the selectivity data was collected using the cover-codend method. Results shows that fixing the geometry of square meshes results in well-defined size selection patterns for flatfish species. This positive feature allows increasing the codend mesh size to maximize escape probabilities of roundfish species such as cod, without risking the catchability of marketable flatfish sizes.

9.8.3.3 A contribution to the understanding of flatfish escaping behavior in trawl codends: the relevance of mesh position relative to the body orientation

Project Full Title: NA

Project Timeframe: Undefined

Institution(s): Thünen Institute of Baltic Sea Fisheries

Contact person: Juan Santos juan.santos@thuenen.de

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Summary: Size selection in trawl gears is determined to a large extend by the ability of a fish (or any organism entering the gear) to pass through the codend meshes. It is generally assumed that such ability is largely determined by the morphology and size of the fish, and the geometry and size of the mesh through which the individual is attempting to escape. I addition, fish behaviour should also be considered a relevant factor to consider in order to better understand the mechanisms involved in codend size selection. Therefore, a good understanding of the escape behaviour of fish species is essential for the development of the next generation of trawl codends. There are an increasing number of studies demonstrating that diamond-mesh codends provide better escape possibilities to flatfish species than other mesh geometries (for example square-mesh and T90 codends). This is because their flat morphology can fit better to the narrow and elongated shape of diamond meshes when subjected to the towing forces. Due to the distinct laterally compressed body morphology of these species, it is reasonable to assume that the advantages of using diamond meshes will only be available if the flatfish makes optimum contact with it. Here, we define optimal contact when the **transversal axis of the fish (body depth)** is **parallel** to the **wider axis of the mesh opening**. However, positioning the body in a way that ensures an optimum contact can be energetically demanding depending on how the fish is positioned relative to the mesh. Thus, it can be hypothesised that the escape opportunities requiring simple body rotations and / or limited hydrodynamic disturbance will be preferred over other more demanding escape options (Figure 9.17).

Sea trials conducted onboard RV/ "Solea" in November 2023 tested the hypothesis formulated above using a dedicated experiment that involved four experimental designs of a cuboid-shape codend made of diamond meshes fixed to opening angles of 40°. Differences between the four designs tested relied on the available selective panels of the codend: 1) the top panel of the codend selective and the remaining three sides non-selective (each masked by a small-mesh net panel), 2) bottom panel of the codend selective, 3) lateral sides of the codend selective, and 4) all four sides of the codend selective (Figure 9.18). Preliminary results show large differences in the size selection observed across the codend designs tested, supporting the abovementioned hypothesis that motivated the experiment. Further analysis of the catch data and video recordings collected during the trials will provide a better understanding on how to maximize escape possibilities of flatfish species in trawl gears.

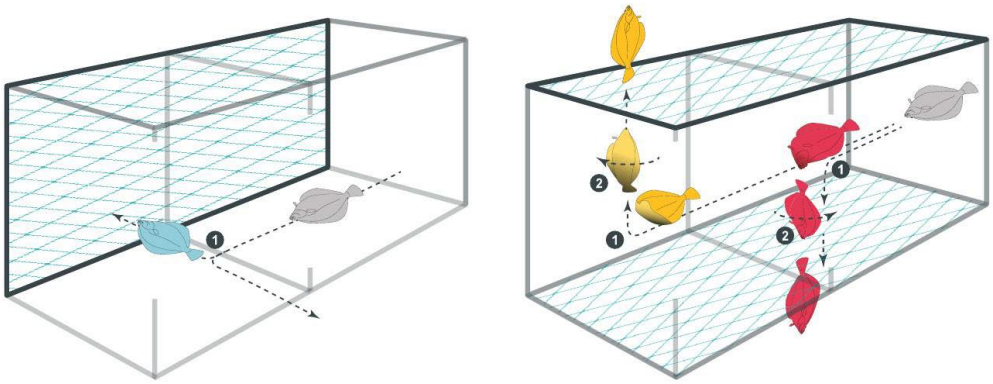


Figure 9.17. The sequence of movements that a flatfish would have to perform in an attempt to escape through the codend meshes depends on its spatial position relative to the targeted mesh.

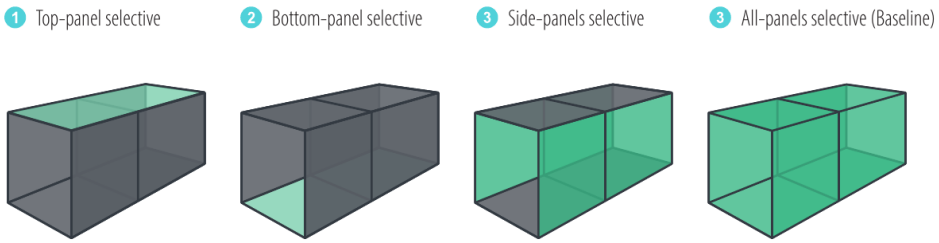


Figure 9.18. The four different codend designs tested during the sea trials.

9.8.3.4 Innovation program

Project Full Title: Innovation program shrimp fishery Schleswig-Holstein

Project Timeframe: 2020-2024

Institution(s): Thünen Institute of Baltic Sea Fisheries,

Contact person: Daniel Stepputtis, daniel.stepputtis@thuenen.de Juan Santos, juan.santos@theunen.de; Annika Brüger, annika.brueger@thuenen.de

Link(s): https://www.thuenen.de/en/institutes/baltic-sea-fisheries/fields-of-activity/research/fisheries-and-survey-technology/fischereitechnik/fischereien/fangtechnische-optimierungen-in-der-nordsee-krabbenfischerei

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Summary: The shrimp fishery in Schleswig-Holstein in Germany has been a traditional profession linked to the culture of the region for over a century, primarily targeting the North Sea shrimp (*Crangon crangon*) with the use of beam trawls.

This fishery faces a variety of challenges that require innovative solutions. One of the challenges is the comparatively high energy requirements and fuel consumption - and the resulting costs. In particular, solutions are needed here that reduce energy consumption, e.g. by reducing drag resistance of the trawls. Another problem arises from the design of the beam trawls used, in particular due to the very small mesh openings, which are designed to effectively catch shrimps. By-caught fish can be sorted out through an inserted sorting device (either sievenet or sorting grid). Despite the selection devices used, juvenile individuals in particular can reach the codend. Due to the small mesh opening, they have little chance of escaping. Optimizing the bycatch selection therefore helps to improve the quality of the shrimp catch. To stimulate and utilize the innovative spirit in the shrimp fishery a special project called "Innovation Program shrimp fishery Schleswig-Holstein" (IPK) was launched on the recommendation of the shrimp fishery council ("Krabbenfischereibeirat") of the Schleswig-Holstein Federal state. The Innovation program is primarily designed to draw on practical experience from commercial fisheries. Fishermen who have an innovative idea that deals with the challenges of shrimp fishing and can contribute to improving the sustainability of this special fishery can apply for financial support from the shrimp fishery council. With the help of this monetary promotion, they have the opportunity to define and implement their idea and get a first impression of its application in practice. Each tested idea is regarded as a small project within the innovation program, which receives a data evaluation and a final report after completion of the tests and is accompanied by scientific research.

In cooperation with the Thünen Institute, the fishermen are developing a strategy for data collection and testing their idea. A central aspect of the project is self-sampling by the fishermen so that they can easily collect the necessary data as part of their normal fishing activities. During the experimental hauls, a beam trawl with the idea or modification (test net) is towed parallel to a conventional beam trawl (standard net). The nets used should be as identical as possible so that the catches and handling of both nets can be directly compared. Any differences in the catch quantity or its composition can thus be attributed to the modification made.

As the catchability of commercial shrimps and bycatch was important for the evaluation of the gear modification within all innovative ideas, the catch composition was sampled in most of the projects. Normally, the respective catch was processed and documented separately for the test net and the standard net. First of all, the total quantity in the hock (catch container) was determined for each net, after which a sample of approximately one liter was taken. This sample was used to record the length distribution of the shrimps caught. The determination of the length distribution of commercial shrimps serves to check whether the tested modification has a length-dependent influence on the catchability of the shrimps. The catch from both nets was then passed separately through a sieve. Here, the marketable shrimps were separated from the undersized shrimps and the bycatch (e.g. fish, invertebrates, stones). The marketable shrimps and the bycatch were collected in baskets for both the test net and the standard net and the respective volume of the catch was then recorded (determined by the number and fill level of the baskets). The catch volumes were noted and documented. In addition, further information such as water depth and catch location was also recorded. The data collected was then analysed in order to identify possible differences in the catchability of the test and standard net.

The individual projects (Table 9.1) dealt with the topics of energy consumption, selection and interaction with the seabed. The topic of energy consumption is primarily concerned with reducing drag resistance in order to achieve the greatest possible energy savings. Reduced energy consumption should above all lead to lower fuel consumption and furthermore to reduced CO_2 emissions. The topic of selectivity deals with all ideas relating to bycatch selection, e.g. the improvement of existing options (sorting grid/sievenet) or the development of new sorting concepts (e.g. "sortingmat"). The topic of interaction primarily includes projects that focus on reducing contact between the net and the seabed, for example to reduce the use of "dolly ropes". The

focus here is particularly on lifting the codend or the entire net. The optimizations of the individual projects concern the various elements of the net and the fishing gear. These include, for example, the net itself (net cut, mesh size and shape), the basic gear (roller chain, curved beam and curved shoes) or the selection device (sieve net or sorting grid). By the end of 2023, 10 different projects had been successfully completed, some of which have already delivered very satisfactory results. After evaluating the projects carried out so far, the overall conclusion regarding the innovation program is very positive. Within the project, many contacts have been made with commercial fishermen who are very interested in continuing to make fishing more sustainable. The exchange of results and experiences confirmed, for example, that the innovation program is well suited to getting a first impression of the ideas and being able to assess the functionality. At the same time, it also became clear that the short project period of the individual projects limits the informative value of the results. However, this compromise between simple implementation of the projects and the scientific validity of the results has already been incorporated into the design of the shrimp fisheries innovation program.

There is still a great need for research in the various focus areas such as energy consumption, interaction with the seabed and bycatch selection. Continuing the innovation program makes a lot of sense from a scientific point of view, as both science and fisheries can benefit from this form of transdisciplinary research. For more information on the individual projects, access to the final reports and the final summary report, please contact the scientific accompaniment of the project.

Table 9.1. Overview of the contents of the "Innovation program"

Project	Name	Topic
02	Grundgeschirr mit achsversetzten Rollen (offset rollers)	The use of "offset rollers" is primarily intended to reduce energy consumption. The aim is to arrange the rollers as parallel as possible in order to reduce the drag resistance of the entire net and protect the seabed.
03	Siebnetz-Modifikation (Sievenet modification)	The fishing industry reports that algae is mainly caught in the sides of the sievenet. As part of the project presented here, the screen net was modified by inserting two additional side panels made of square meshes, which should reduce or completely prevent material from becoming trapped.
04	Veränderter Netzzuschnitt (modified cutting)	A change in the net cut is intended to increase the distance between the net and the seabed. The side panels of the net extend into the bottom panel and also have beveled sides on the underside. This pulls the entire bottom sheet slightly upwards, which should result in less ground contact and lower drag resistance.
05	Alternatives Auftriebsnetz (alternative buoyancy net)	The attachment of ropes with buoyancy elements is intended to lift the entire net in order to reduce or completely avoid contact between the net and the seabed, which should also reduce fuel and energy consumption.
06	Hosensteert (splitted codend)	By using a splitted codend, the weight of the entire catch is distributed over two separate codends. This should prevent the net from rubbing against the seabed as much as possible.
07	Siebmatte (Sievemat)	The sievemat serves as a possible alternative to the sievenet. While the sievenet is installed as a funnel in the actual shrimpnet and is intended to guide the unwanted bycatch out of the net, the sievemat is installed in front of the net opening. This is to prevent large bycatch from entering the net in the first place.
08	Reifen als Kurrschuhe (Tires instead of trawl shoes)	The use of tires instead of commonly used "trawl shoes" is intended to reduce the impact on the seabed and lower energy consumption. Tires offer several advantages over conventional trawl shoes, as they are mobile and have a smaller contact area with the seabed. By rolling the tires, the frictional resistance between the contact surface of the tires and the seabed is reduced compared to conventional trawl shoes.
09	Gerades Grundgeschirr (straight bottom gear)	In particular, the concept of the "straight bottom gear" eliminates the disadvantages of the rollers being pulled at right angles to the towing direction on a conventional bottom gear. By using a straight bottom gear, all rollers should run in the direction of towing, which, in addition to protecting the seabed, should also lead to less sediment being stirred up and lower energy consumption.
10	Steertboje (Buoyancy ball)	Attaching a buoyancy ball to the codend offers an easy way to increase the distance between the codend and the seabed. The buoyancy ball is attached to the codend with a simple snap hook and a line and can be easily removed or replaced at any time.

11	Oberblatt-Modifikation (top panel with big meshes)	The insertion of enlarged meshes (400 mm mesh size) in the top panel of the fishing net is intended to provide fish in particular with an additional means of escape. The large meshes make it possible for by-catch to leave the net before the selection device (sievenet or sorting grid) and not have to be laboriously sorted out of the catch. In addition, the large meshes are intended to reduce drag, which in turn leads to energy and fuel savings.

9.8.3.5 Smart Fishing

Project Full Title: OTC-smartFishing

Project Timeframe: 01.10.2021 – 30.09.2024

Institution(s): Thünen Institute of Baltic Sea Fisheries,

Contact person: Daniel Stepputtis, daniel.stepputtis@thuenen.de; Mathis Mahler, mathis.mahler@thuenen.de

Link(s): www.thuenen.de/en/smartfishing

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Summary: Our work in SmartFishing aims to develop a robust underwater camera system with AI-assisted image recognition for marine organism detection and classification. The system should be applicable in commercial and scientific trawls. The long-term goal is to be able to specifically avoid unwanted bycatch, to record the fish stock in terms of size, species and health status for fisheries research, and to deepen the understanding of ecosystems and fishing grounds, through spatially and temporally high-resolution data acquisition directly in the net. Currently we are in a prototype status, with a prototype of the camera system that is self-developed by our partners Framework Robotics. It consists of a stereo camera, 2 LED-Lights, a control unit (as shown in Figure 9.19) and an extra battery container. The system can either be used with a winch to have a live connection to the camera and controls or used purely with the battery to be less restricted in depth and resources.

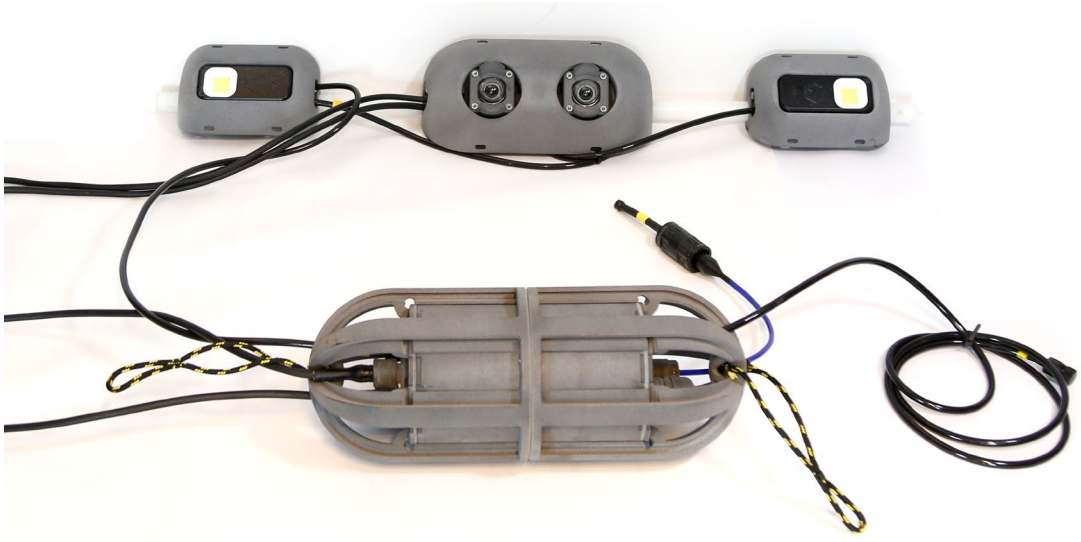


Figure 9.19. SmartFishing-System consisting of two powerful LED-Lights, Stereocamera in the middle and a container with all needed hardware.

Our AI-system, a retrained version of YOLOv7 with Tracking from SORT, is currently trained with images from action-cams that we deployed in the trawl. We are currently waiting for our partners for the annotation for images from the new system in order to finetune the AI to the new perspectives of our new camera system. Figure 9.20 is showing a rare shot, where the system got it almost right, while Figure 9.21 shows the more typical problems the current model has. From experience we know though that the model will improve with further training on the new data, so we are confident to see an improvement in the coming months, and expect a similar

performance as is visible in Figure 9.22 and Figure 9.23. But Figure 9.20 and Figure 9.21 also show the potential of the system, like a very broad field of view with perspective both on the bottom and to the side of the trawl tunnel and a sharp image with extra controllable lights.

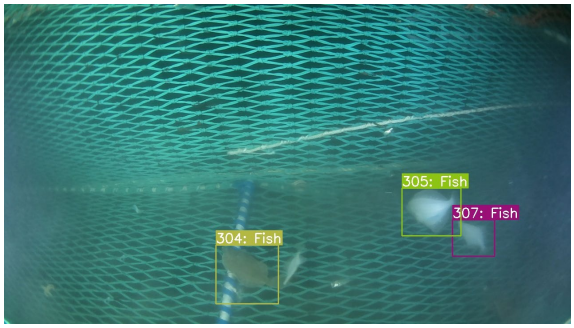


Figure 9.20. Detection of the fish almost perfect.

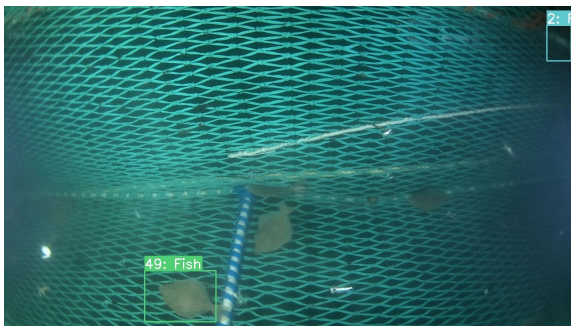


Figure 9.21. AI system fails to detect all fish and mistakes the top right corner for a fish.

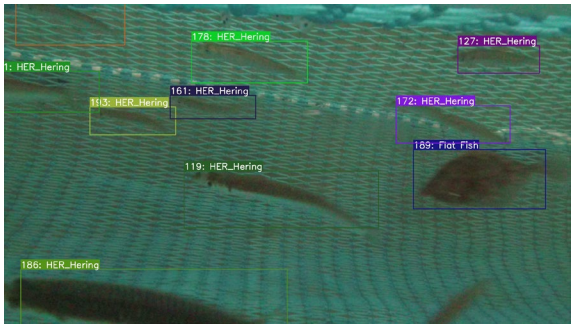


Figure 9.22. Detection on previous data (1).

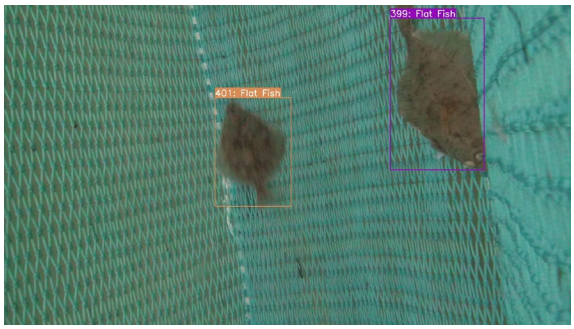


Figure 9.23. Detection on previous data (2).

9.8.3.6 Development of technical bycatch mitigation strategies for gillnet fisheries - STELLA2

Project Full Title: Development of technical mitigation approaches towards minimizing conflicts in gill net fisheries and conservation objectives and subjects of protection in the EEZ of the Baltic Sea

Project Timeframe: 01.11.2021 – 31.10.2024

Institution(s): Thünen Institute of Baltic Sea Fisheries, German Maritime Museum, NABU, DTU Aqua

Contact person: Daniel Stepputtis daniel.stepputtis@thuenen.de , Thomas Noack Thomas.noack@thuenen.de , Andrea Milanelli mailto:hannah.schartmann@thuenen.deandrea.milanelli@thuenen.de , Sara Berzosa sara.berzosa@thuenen.de

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Summary: Within the previous project STELLA (https://www.thuenen.de/en/of/projects/fisheries-environment-baltic-sea/gill-net-fisheries-development-of-alternative-management-approaches-stella/) technical measures were developed to reduce bycatch of marine mammals (harbour por-poises) and diving seabirds. These technical measures include gillnet modifications as well as the development of alternative gears such as fish pots and pontoon traps. These devices are now to be tested on a larger scale under commercial settings.

Gillnets equipped with acrylic glass spheres ("PearlNets") have a substantially higher echo than standard gillnets, making them more detectable for harbour porpoises. A first pilot trial in the Black Sea (STELLA) has shown promising results. Within STELLA2, a catch comparison of normal gillnet and PearlNet (no significant differences in catches) has been carried out and a large-scale mitigation trial will be conducted in spring 2024 (joint venture of STELLA2 and CIBBRiNA). Further tasks in the project are i) the production of PearlNets, which shall at some point happen in an automatized way and ii) the consideration of other materials than acrylic glass to facilitate recycling of PearlNets.

Figure 9.24. Gillnet with Acrylic-pearl (diameter: 8 mm).

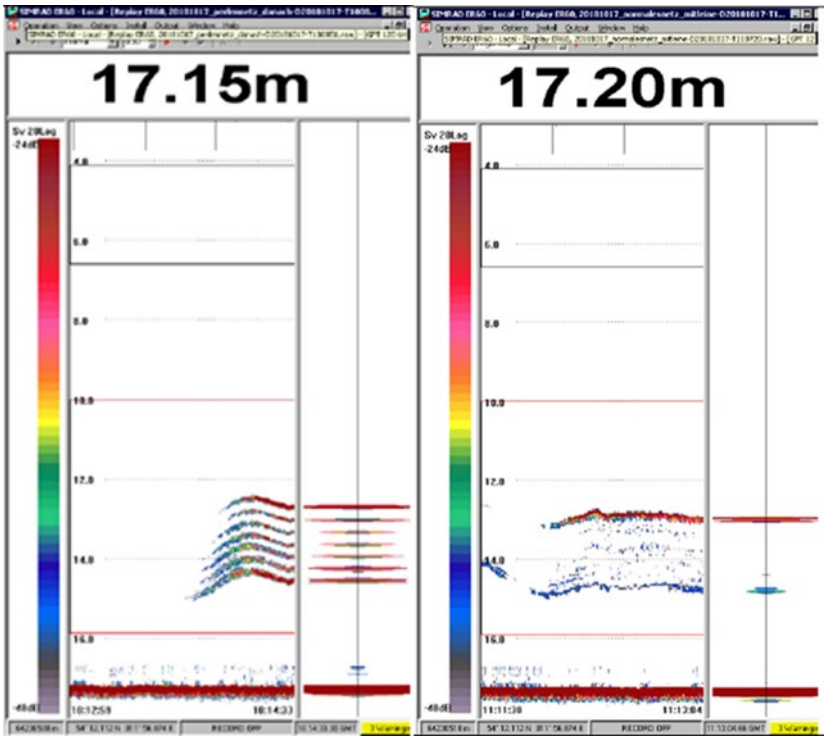


Figure 9.25. Echograms taken with the sonar (SIMRAD EK60, 120 kHz) of FRV "Clupea": Left: standard gill-net without pearls; Right: modified gillnet with pearls.

Alternative Gears

Within STELLA, an "ideal" entrance and retention within a fish pot was developed for cod and other roundfish. Within STELLA II, these results could be verified in a commercial fishery but showed the importance of properly set retention devices to avoid fish from escaping. Furthermore, the systematic studies to construct an "ideal" fish pot for other species such as flatfish continued, resulting in a Mulispecies entrance, which could also be tested in the field.

The pontoon trap has been modified to make it suitable for rougher environments as well as different target species (herring, garfish, cod, flatfish). The first model of the new design is in commercial use since March 2024, where it could achieve first diverse catches and will be further optimized in close collaboration of scientists, fisher and netmaker.

Figure 9.26. Experimental setup for fish pot entrance trials. A: Two net pens, the left one to hold the fish and the right one for conducting the experiment. B: Inside the experimental net pen, a PVC frame fish pot with two adjacent entrances and an Infra-Red camera

Figure 9.27. Pontoon trap in German waters (water depth at position of pontoon trap is approx. 3 m)

9.8.3.7 MiniSeine in the Baltic fishery

Project Full Title: Evaluation of the MiniSeineine as potential gillnet alternative in the Baltic Fishery

Project Timeframe: 01.01.2022 – 31.12.2023

Institution(s): Thünen Institute of Baltic Sea Fisheries, DTU Aqua

Contact person: Thomas Noack Thomas.noack@thuenen.de, Daniel Stepputtis, daniel.stepputtis@thuenen.de

Link(s): https://www.thuenen.de/en/institutes/baltic-sea-fisheries/projects/fisheries-and-survey-technology/miniseine-eine-kleine-snurrewade-fuer-die-deutsche-kuestenfischerei

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Summary: The MiniSeine system (Danish seine reduced in size in order to be operable from a gillnetter) has been tested, evaluated, modified and improved by DTU since 2018. As results showed that the gear is capable of reaching catches comparable to gillnets and additionally chances of catch loss due to raiding seals are much more unlikely, it can be considered a potential gillnet alternative. Additional ecological advantages of the gear over set gillnets are the expected reduced catches of species protected under the EU Habitats Directive (Directive 92/43/EEC) and the Bird Directive (Council Directive 2009/147/EC) such as harbour porpoise (*Phocoena phocoena*) and different sea-birds, and the reduced risk of ghost nets in the area.

In order to evaluate the gear in other areas then the waters around Bornholm (exclusive trial area so far), the aim of this project was to test the MiniSeine in German waters. After some handling issues in the beginning of the trials, the fisher was able to to handle the gear well with help of one scientist on board. This could be changed by modifying the system in a way that in can be operated by a single person. Catch compositions as well as catch numbers were comparable to catches of gillnetters fishing in the same area. For future trials and a potential commercial uptake of the gear, it should be borne in mind that the use of the MiniSeine is limited to rather flat and sandy areas and that the tested prototype would need to be changed in a way to make the system stronger and more robust.

Figure 9.28. Mini seine system installed onboard the Danish fishing vessel being involved in previous work with it.

9.8.3.8 Best Practice in Bycatch Reduction - CIBBRiNA

Project Full Title: Coordinated Development and Implementation of Best Practice in Bycatch Reduction in the North Atlantic, Baltic and Mediterranean Regions

Project Timeframe: 01.09.2023 – 31.08.2029

Institution(s): Thünen Institute of Baltic Sea Fisheries and (many) others.

Contact person: Daniel Stepputtis daniel.stepputtis@thuenen.de , Thomas Noack Thomas.noack@thuenen.de , Andrea Milanelli mailto:hannah.schartmann@thuenen.deandrea.milanelli@thuenen.de , Sara Berzosa sara.berzosa@thuenen.de

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Summary: The main objective of LIFE CIBBRiNA is to minimise and, where possible, eliminate bycatch mortality of priority ETP species. The role of Thünen Institute of Baltic Sea Fisheries is hereby the further development of the PearlNet and it´s practical test in different regions as for instance Iceland (see 2.1.1.4 Development of technical bycatch mitigation strategies for gillnet fisheries - STELLA2).

9.9 Iceland

9.9.1 Contact person

Haraldur A. Einarsson, Marine and Freshwater Research Institute (MFRI).

haraldur.arnar.einarsson@hafogvatn.is

9.9.2 Projects

9.9.2.1 FishScanner

This project, initiated in 2018 through a collaboration between the Marine and Freshwater Research Institute, StarOddi, and Hampiðjan, aims to develop a lightweight, user-friendly device that provides real-time information on catch composition. The device, named FishScanner, features a circular frame equipped with stereo cameras and lights positioned in front of the codend. It scans all fish before they enter the codend and processes the data in real-time using artificial intelligence on a computer onboard the vessel. The device can connect to the vessel via either a coaxial or fiber optic cable for enhanced data quality or operate as a standalone system, though this latter option does not support real-time observation.

The FishScanner represents a significant advancement for scientific research and commercial fisheries employing towed fishing gear. Prototypes have been tested at sea on both research vessels and commercial trawlers. The project has produced a version of the FishScanner tailored for commercial fisheries, providing fishermen with real-time data on catch composition, including species and size distribution. Tests on a commercial trawler demonstrated its utility as a research tool, allowing tows through dense schools of fish with the codend open while still obtaining accurate information on species and size composition in the towed area.

Although the project has exhausted its formal funding, it continues to progress with further developments. The project team is keen on advancing the FishScanner, potentially towards remote selectivity capabilities, contingent upon securing additional grant funding.

9.9.2.2 Fishing gear as a contributor to the problem of marine plastics

After establishing a classification scheme and implementing a registration protocol, the Marine and Freshwater Research Institute (MFRI) began registering all marine debris found during its surveys in 2019. The debris is categorized into three main classes: fishing gear, marine industry, and waste. Within the fishing gear class, debris can be further classified by gear type or specific

parts, such as trawl nets, longlines, or flotation devices. Data collection will continue over the coming years, allowing for the monitoring and analysis of waste distribution within the Icelandic Exclusive Economic Zone (EEZ). As the dataset grows, it will become increasingly valuable, serving as a potential indicator of trends in the magnitude and types of marine waste in the North Atlantic Ocean over time. This dataset will also be a valuable resource for many other projects related to abandoned, lost, or otherwise discarded fishing gear (ALDFG) or similar issues.

9.9.2.3 Mortality rate of Anarhicas minor from various fishing gear

The spotted wolffish (Anarhicas minor) stock is critically low, with biomass and juvenile indices at historical lows and below biomass reference points. Consequently, advised catch levels are expected to decline, and a potential landing ban may be recommended if fishing mortality is not reduced. Tagging research by the Marine and Freshwater Research Institute (MFRI) and catch-and-release studies for aquaculture indicate a high survival rate for spotted wolffish. Canadian research estimates that Atlantic wolffish, a similar species, have over a 90% survival rate if released within two hours of capture (Grant & Hiscock, 2014). Preliminary results from MFRI's 2020 autumn survey suggest spotted wolffish can survive up to two hours on fishing ramps and conveyor belts. Additionally, MFRI's research on longline catches indicates a high survival rate for released spotted wolffish. In late 2020, fishermen were granted licenses to release spotted wolffish, with mandatory logbook registration to estimate released quantities. From ongoing research, preliminary results show a high survival rate for spotted wolffish caught in trawls and longlines. In the longline test two release methods are under focus, that is: After passing through the crucifier and by cutting the snood line before the crucifier. Further data collection will be done throughout this summer with hopefully following up with data analysis.

9.10 Ireland

9.10.1 Contact person

Matthew McHugh BIM, matthew.mchugh@bim.ie

9.10.2 Summary

- Irish research in 2023 relevant to FTFB primarily focused on energy efficiency and the development of image acquisition technology. We also published a paper on using survivorship pop-up satellite tags to assess cod (*Gadus morhua*) survival in a bottom seine-net fishery.
- Future research is focused on selectivity, fish survival, improving energy efficiency as well as fisheries interaction with offshore windfarms.

9.10.3 Projects

9.10.3.1 Preliminary assessment of reduced-drag Pluto trawl doors

Project Timeframe: 2023

Institution(s): BIM

Contact person: Matthew McHugh, Matthew.mchugh@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This trial primarily aimed to improve energy efficiency. The (1.1 m2) Pluto doors were assessed against two different sized trawl doors, a 1.6 m2 in a Nephrops and a 2.1 m2 in a white-fish fishery. The Pluto doors are high aspect (taller than long) and are likely to be very stable due to a low centre of gravity. The Pluto trawl doors reduced load which is linked to fuel and carbon use. The Pluto doors also show potential to reduce seabed impacts. Further assessment of their energy reduction benefits is planned in 2024.

Figure 9.29. Polar door with Marport sensor on towing warp.

9.10.3.2 Preliminary assessment of MLD off-bottom trawl doors in the Irish Nephrops fishery

Project Timeframe: 2023

Institution(s): BIM

Contact person: Matthew McHugh, Matthew.mchugh@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This trial primarily aimed to improve energy efficiency. The assessment was in the Nephrops fishery using a two-warp half-quad configuration, with the (1.74 m2) MLD doors compared against (2.25 m2) conventional doors. The MLD doors have onboard altimeters and adjustable flaps that control their position in the water column above the seabed. The MLD doors remained off the seabed for 89% of haul times. The wingend spread was reduced but with no reduction in swept area. The MLD doors reduced load by 6% and fuel usage by 8% compared to the conventional doors. Further work is needed on optimisation of off-bottom doors with different trawl configurations.

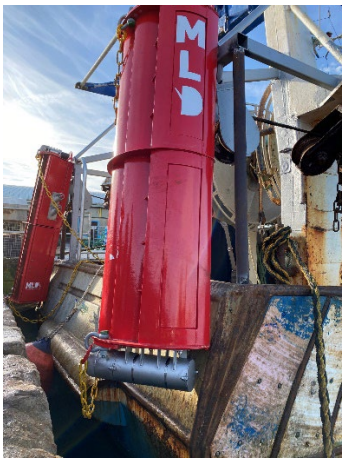


Figure 9.30. MLD doors on stern of trial vessel.

9.10.3.3 Assessment of pair-fishing operations in the Irish demersal seine fishery

Project Timeframe: 2023

Institution(s): BIM

Contact person: Martin Oliver, martin.oliver@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This study aimed to assess the practicalities and energy efficiency of pair seining in a fishery targeting mixed-demersal fish species in the Celtic Sea. The pair seine vessels reduced their fuel use and greenhouse gas emissions by 25%, and load by 32% on average during fishing. In contrast to solo operations, pair-seining successfully caught fish during hours of darkness.

The trial demonstrated that Irish solo seiners can successfully team up and catch fish effectively while greatly reducing fuel consumption, greenhouse gas emissions and engine load. This was the first time these vessels undertook pair-seining operations.

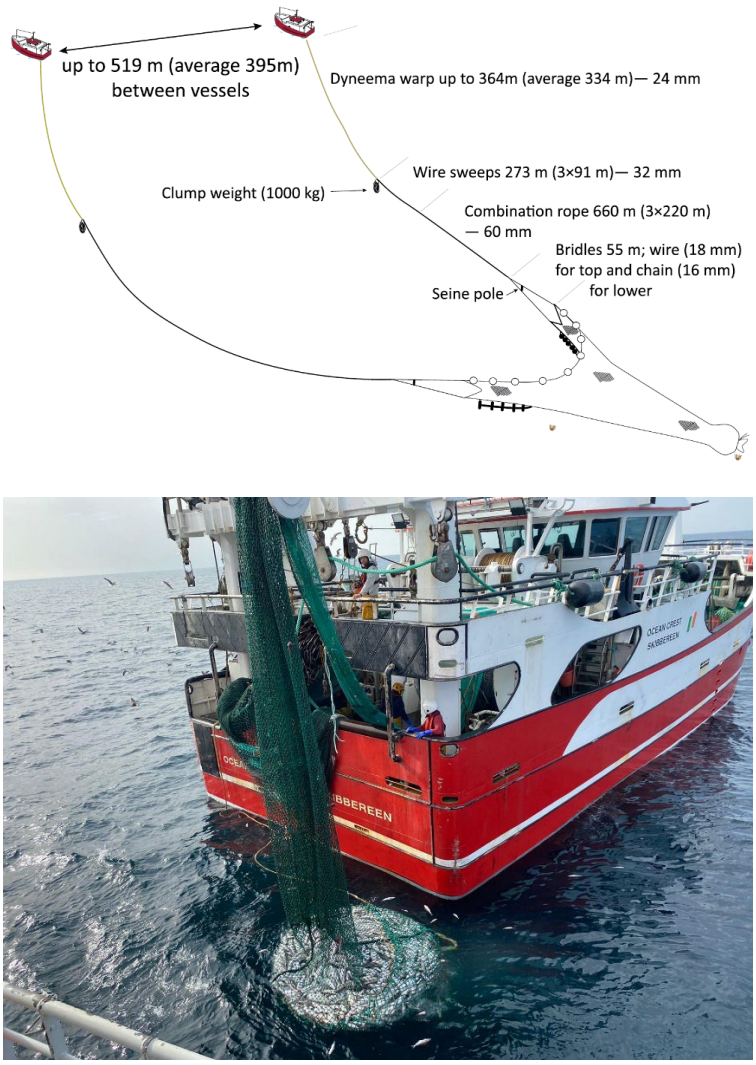


Figure 9.31. Pair-seine configuration (top) and fishing operations hauling in the codend (bottom).

9.10.3.4 Assessment of artificial light on the headline towards improving energy efficiency in the Celtic Sea trawl fishery for demersal fish species

Project Timeframe: 2023

Institution(s): BIM; Atlantic Technical University (ATU), Galway, Ireland.

Contact person: Martin Oliver, martin.oliver@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This trial primarily aimed to improve energy efficiency in a mixed demersal fishery. The assessment was completed in the Celtic Sea using a single rigged otter trawl with 14 Lindgren-Pitman® green light emitting diodes (LEDs) attached to the trawl's headline, with ~ 150 cm spacing between each light. There was a 51% increase in haddock catch weight with lights on the headline during nighttime and 9% reduction with lights on the headline during daytime. This

increase in haddock catch at night lead to a 64% increase in the value of haddock. The lights offer a simple, inexpensive option to boost catch and energy efficiency.

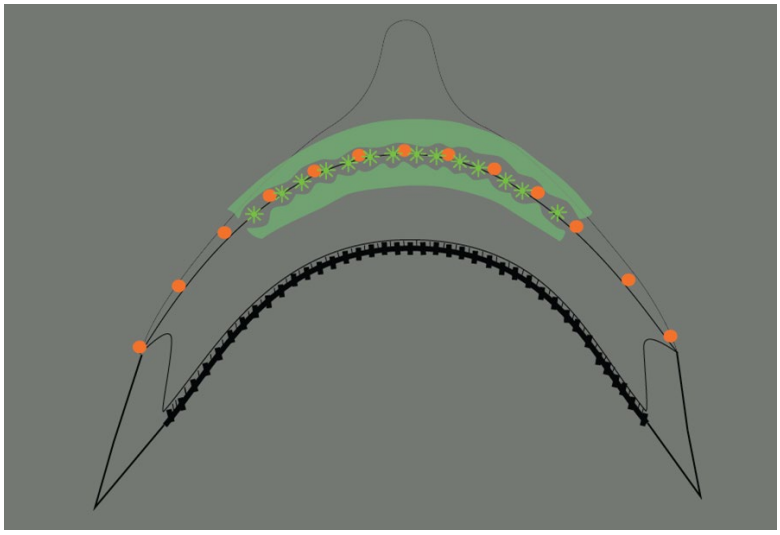


Figure 9.32. Trawl with 14 green artificial lights on the headline.

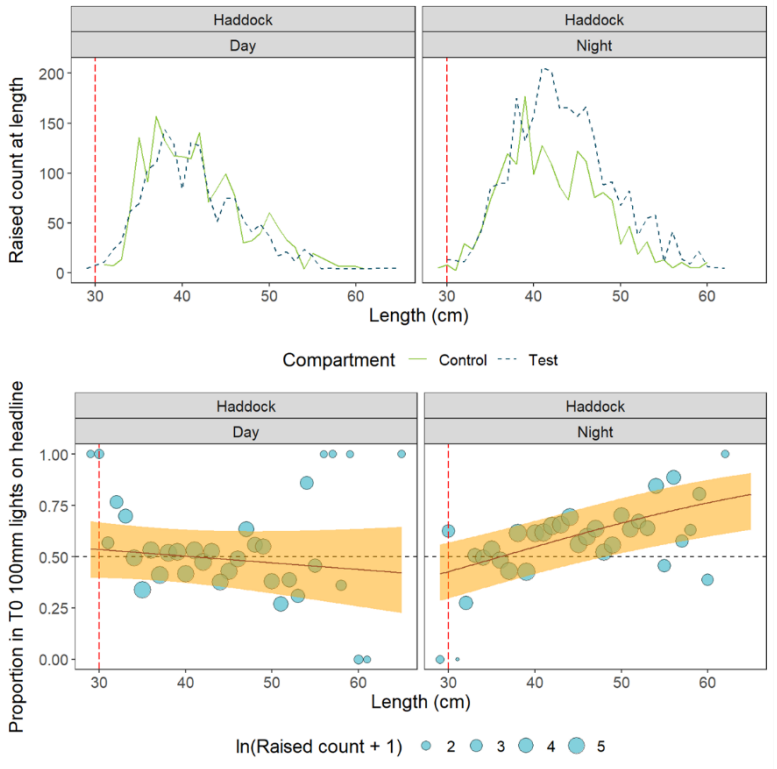


Figure 9.33. Length frequency distributions (LFD) (top) and catch curves (bottom) for haddock. Navy hatched line represents the test gear and green solid line represents the control gear in the LFD plot. Overall modelled proportions of haddock catch at length in the test gear are outlined in the catch curves by day and night. Points represent the empirical raised proportions over all hauls with point sizes proportional to the raised counts. Model fit and 95% confidence intervals (yellow band) come from the GAM. Vertical lines represent the minimum conservation reference size for haddock (≥ 30 cm) (bottom).

9.10.3.5 Assessment of cod survival in the Irish seine-net fishery using pop-up satellite archival tags

Project Timeframe: 2022–2023

Institution(s): BIM; Atlantic Technical University (ATU), Galway, Ireland.

Contact person: Martin Oliver, martin.oliver@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This work follows a successful trial (reported on in 2022) that is now published in the Journal of Fisheries Research. This study demonstrates the effectiveness of pop-up satellite archival tags in assessing cod survival in a fly-shoot seine net fishery with major potential application to other species and fisheries.

Figure 9.34. Cod with bridle system and satellite archival tag.

9.10.3.6 Assessment of image acquisition and sediment suppression systems in the Irish Nephrops fishery

Project Timeframe: 2023

Institution(s): BIM; Atlantic Technical University (ATU), Galway, Ireland.

Contact person: Daragh Browne, daragh.browne@bim.ie

Link(s): www.bim.ie/publications/fisheries

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The trial assessed the practicalities of an image acquisition system with sediment suppression in an Irish prawn (Nephrops norvegicus) fishery. The trial took place in ICES division 7b with a single 23ftm Nephrops trawl. The image acquisition section was in the codend section and comprised a box shaped tarpaulin, stereo GoPro Hero10 cameras and underwater lights. The sediment suppression system (a 3 m wide by 5 m long tarpaulin, attached to the footrope) was used to increase image clarity (Figure 9.35). The image acquisition system worked well, and high-quality images were obtained. The sediment appears to have entered the trawl aft of the sediment suppression system and further work on sediment suppression and trawl design is required to improve consistency of imagery.

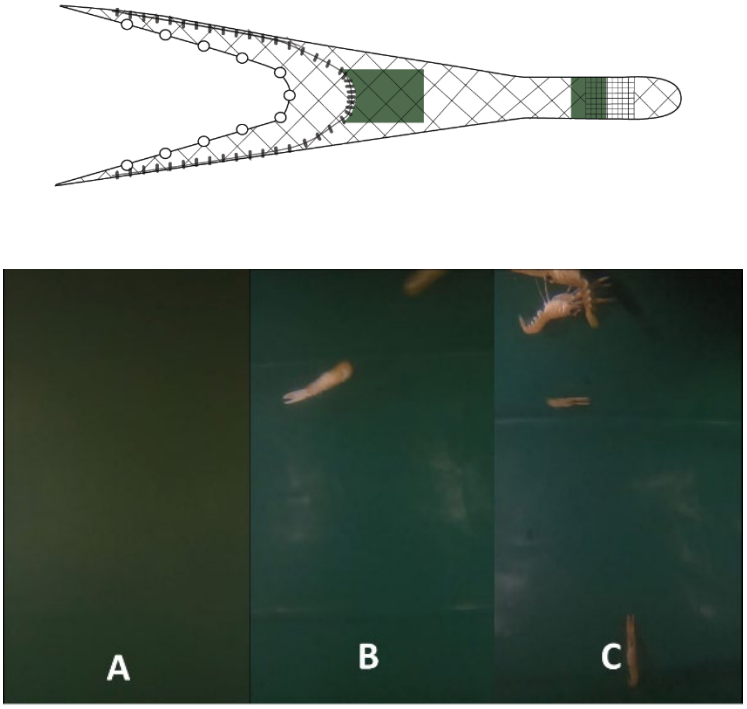


Figure 9.35. Placement of the sediment suppression system in the trawl (top), and image classification (below); A—excessive suspended sediment; B—intermediate levels of suspended sediment; C—and low levels of suspended sediment.

9.10.4 Future projects and Ideas

9.10.4.1 Progress Report on Spurdog Survivability in Irish Fisheries

Estimated Project Timeframe: January 2023 – December 2024

Institution(s): BIM, Atlantic Technical University (ATU), Galway, Ireland.

Contact person: Martin Oliver, martin.oliver@bim.ie

Link(s): www.bim.ie/publications/fisheries

Collaboration welcome?: NA

Funding secured?: Y

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This study aims to assess post catch and release survival of spurdog (*Squalus acanthias*) in the Irish demersal trawl and gill net fisheries. We developed a tailored approach to spurdog survival assessment which takes account likely differences in survival between fisheries, results of condition assessments, and practicalities of deploying survivorship pop-up archival tags (SPATs). There is a currently a survival exemption for spurdog over 100 cm in length.

The study to date:

- Over 500 spurdog assessed in trawl and gill net fisheries off the Irish coast.
- Trawl-caught spurdog condition is clearly related to their size with most spurdog over 80 cm in length observed to be in good condition. 90% of spurdog between 80 and 100 cm in good condition survived the capture process.
- Spurdog <80 cm were considered too small for tagging with SPATs
- Ten trawl caught spurdog (80–100 cm) in good condition were tagged with SPATs and their preliminary survival estimate is 68%.
- Further survivability work is planned in Irish trawl and gillnet fisheries

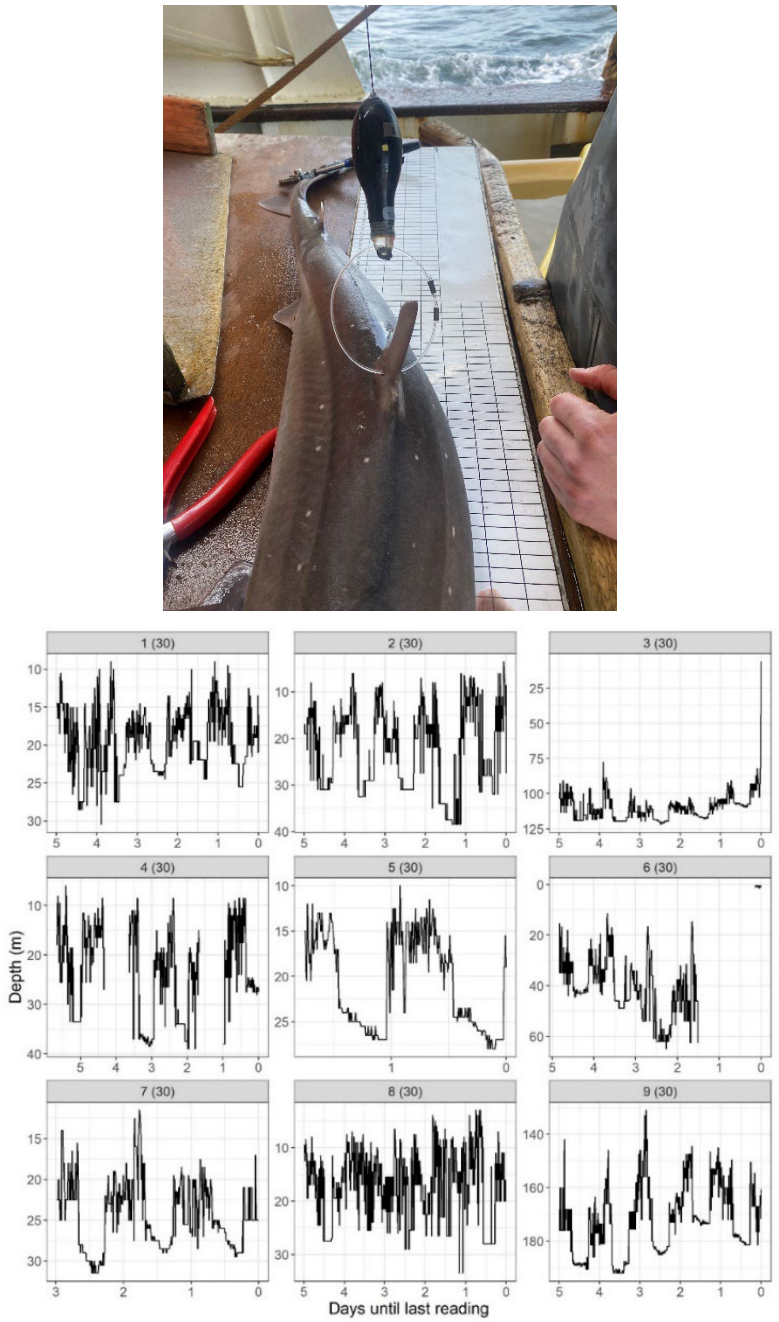


Figure 9.36. Spurdog with SPAT affixed to primary dorsal fin ready for release (top) and vertical behaviour of spurdog in days preceding tag pop-ups (bottom).

9.10.4.2 Assessment of Scallop Dredge Ring Size Selectivity in the Western English Channel Fishery

Estimated Project Timeframe: January 2023 – December 2024

Institution(s): BIM, Atlantic Technical University (ATU), Galway, Ireland.

Contact person: Daragh Browne, daragh.browne@bim.ie

Link(s): www.bim.ie/publications/fisheries

Collaboration welcome?: NA

Funding secured?: Y

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project objective is to assess the selectivity of king scallop (*Pecten maximus*) with 85-, 92-, and 97-mm ring sizes in a scallop dredge fishery. The first trial took place in ICES division 7.e onboard an Irish registered scallop dredger with 10 dredges per side. The 85 mm rings were deployed on 10 dredges on the starboard beam while 92 and 97 mm were alternated along the port beam. Key findings were:

- Increasing dredge ring size from 85 mm to 92 mm could help optimise scallop size selectivity in the western English Channel fishery.
- The 97 mm ring size is considered too large in the western Channel but may be of benefit in the eastern Channel (ICES 7.d).

A future trial in ICES division 7.d is planned where a similar trial will again assess scallop selectivity.

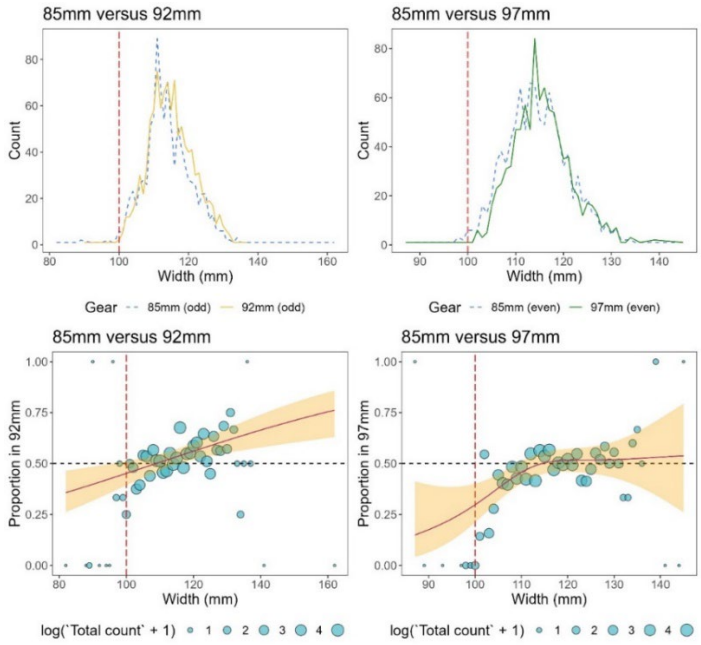


Figure 9.37. Scallop width-frequency plots by ring size (top) and catch comparison curves (bottom) from the first part of the project. Overall proportions of scallop catch at width in control and test gears are modelled in the catch curves. Points represent the empirical proportions over all hauls and size is proportional to the count at width. Model fit (solid red line) and confidence intervals (yellow band) come from the GAM. Vertical dashed line represents the MCRS for scallop (≥100 mm).

9.11 Italy

9.11.1 Contact person

Antonello Sala, National Research Council (CNR), antonello.sala@cnr.it

9.11.2 Summary

The 2024 WGFTFB national report from Italy describes the CNR-IRBIM's research activities. Projects – relevant for the WGFTFB topict - are conducted within the framework of research, development and innovation projects, both national and international, under regionally directed funding programs (POR FEAMPA – Regional Operational Program of the **European Maritime Affairs Fund Fisheries and Aquaculture (EMFAF)** and ROP ERDF – Regional Operational Program of the **European Regional Development Fund**) or ministerial (**PRIN** – Projects of significant national interest, **PNRA** – National Antarctic Research Program, European Territorial Cooperation programs (**Interreg**), direct funding programs of the European Commission (**Horizon2020** and **Horizon Europe**, **Life**, **JPI – Joint Programming Initiatives**, **ERA-NET Cofund**). Thematic collaboration initiatives run by international organizations such as FAO, and GFCM (**General Fisheries Commission for the Mediterranean**). The Institute also develops funded projects in the context of collaborations with private companies in the sectors of the **blue economy** as well as technology transfer and research results. Research projects, mainly of a collaborative nature, are developed through a wide network of partners that include major Italian and foreign research institutions and universities.

9.11.3 Projects

9.11.3.1 Life DELFI

Project Full Title: Dolphin Experience: Lowering Fishing Interactions (LIFE18 NAT/IT/000942)

Project Timeframe: January 2020 – December 2024

Institution(s): National Research Council (CNR)

Contact person: Alessandro Lucchetti, alessandro.lucchetti@cnr.it

Link(s): https://www.irbim.cnr.it/en/progetto-dettagli/delfi/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Life DELFI aims at reducing interactions between dolphins and fishing activities through technical, management and socio-economic measures. Conservation activities will mainly focus on the bottlenose dolphin (*Tursiops truncatus*), although the transversal actions of the project will also extend to other species of cetaceans facing threats caused by fishing activities. The project will last 5 years, and is co-financed by the European Union as part of the Life Program for the conservation of endangered species and habitats. DELFI covers many localities along the Italian and Croatian waters and involves 8 partners, including Universities, NGOs, MPAs and research institutes. The specific objectives of the Life DELFI Project are:

- To reduce interactions between dolphins by 1) encouraging the use of pots as dolphin-safe and alternative gears to the passive nets 2) testing deterrent devices, including interactive pingers (DiD-01 by STM) and visual deterrents (LEDs), both in set nets and trawl fisheries.
- To promote citizen science and dissemination activities aimed at increasing public awareness on dolphins' conservation.
- To engage fishers through specific training courses on more sustainable economic alternatives, such as dolphin watching, and on how to deal with entanglement and bycatch events.
- To investigate interactions through passive acoustic and visual (e.g. photo-identification) monitoring

In collaboration with the Università Politecnica delle Marche, Department of Information Engineering, a new interactive acoustic deterrent device based on dolphin recognition through artificial intelligence is being developed. The device comprises a receiving part, a computing microPC and an emitting part. Each component is designed to be inexpensive and versatile to allow for future modifications and additions. A cost-effective underwater sound-recording architecture, by employing inexpensive (less than 10 euros) and widely used components was already developed and validated. This system has minimal impact on recording performance when compared to commercial counterparts. The new device also incorporates a first attempt of a Convolutional Neural Network (CNN) capable of quasi-realtime processing of the signal, followed by the execution of a sequence of tasks. These tasks encompass the automated identification of bottlenose dolphin (*Tursiops truncatus*) whistles (more than 90% of accuracy) and the emission of deterrent sounds to deter dolphins from fishing nets.

9.11.3.2 NATIONAL BIODIVERSITY FUTURE CENTRE – SPOKE 2

Project Full Title: National Biodiversity Future Centre - Reduction of fishing impacts and protection of biodiversity

Project Timeframe: September 1, 2022 - August 31, 2025

Institution(s): National Research Council (CNR)

Contact person: Alessandro Lucchetti

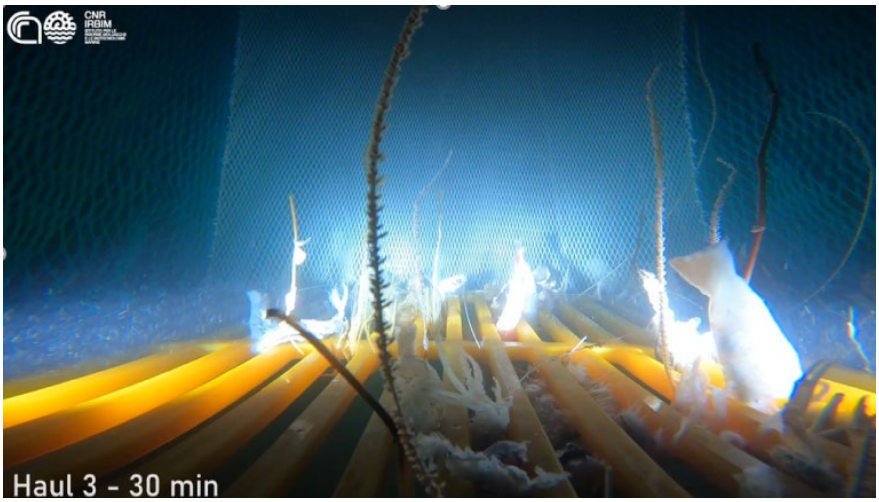
Link(s): https://www.nbfc.it/en/sea

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: *Reduction of bycatch and discards:* In collaboration with operators of the fishing sector, technical solutions (Bycatch Reduction Devices - BRDs) have been developed to avoid the capture of undersized individuals (e.g. Juveniles and Trash Excluder Device or JTED). In particular, a flexible grid with bars spaced 20 mm each other was tested to assess its efficiency to reduce the juveniles catch while maintaining the commercial catch. The narrow spacing will let juveniles of target species (e.g. hake) pass through these bars and reach the escape opening. The lower part of the grid has a hole that guide bigger animals towards the codend. However, commercial loss was consistent. The project is also working on setting standards for TEDs (Turtle Excluder Devices) in the Mediterranean trawling.



New pinger: a prototype of more interactive pingers was developed in close collaboration between CNR-IRBIM and Marche Polytechnic University, Faculty of engineering following the activities initiated during the Life Delfi project (LIFE18 NAT/IT/000942). The device has an improved algoritm capable of detecting dolphins clicks and able to activate only in their presence, since the existing ones are not interactive and represent an additional source of noise pollution.

Green fishing gears: gear modification (such as modified groundrope) and new generation otterboards will be soon tested to reduce towing drag and consumption in trawling and thus increase efficiency. The fuel consumption and the eventual energy saving through these modifications will be monitored through ad hoc instrumentations mounted onboard the vessels.

Line fisheries: Technical innovations in longlining and line fishing will be introduced soon to a) modernise traditional fishing activities, b) make them safer, c) reducing the catch of sensitive species. In particular, line setters and automatic squid jigging machines will be introduced.

9.11.3.3 ECOSCOPE

Project Full Title: Ecocentric management for sustainable fisheries and healthy marine ecosystems

Project Timeframe: September 1, 2021 - August 31, 2025

Institution(s): National Research Council (CNR)

Contact person: Giuseppe Scarcella

Link(s): https://www.irbim.cnr.it/en/progettodettagli/ecoscope

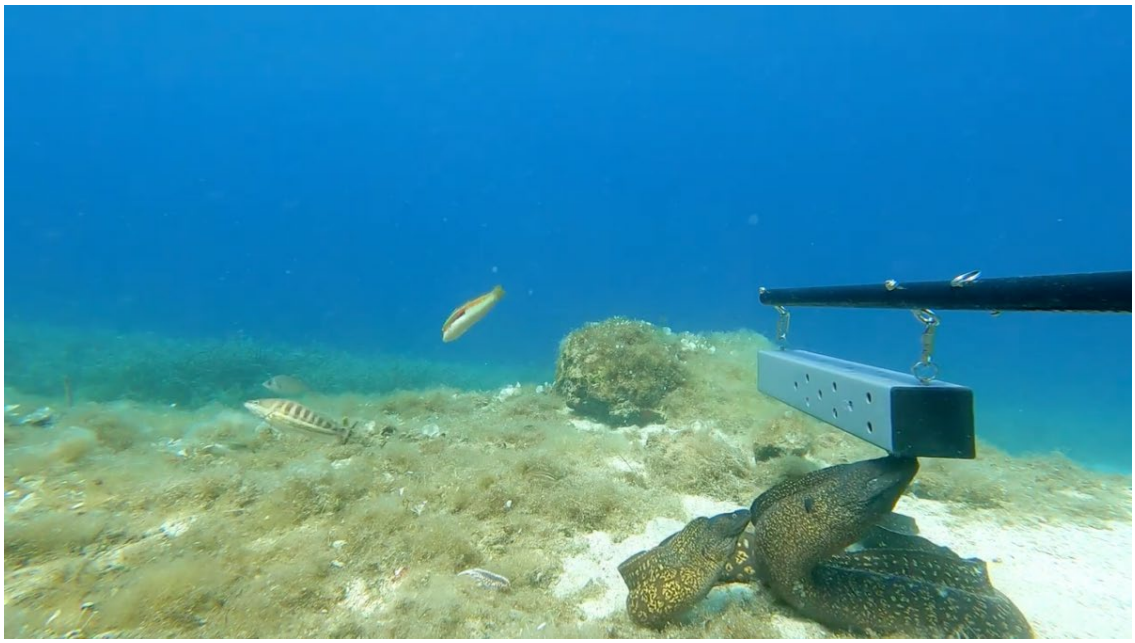
Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: EcoScope aims to promote an effective ecosystem-based approach to fisheries management in European seas. EcoScope will develop an interoperable platform, a tool (toolbox) to facilitate decision-making, a series of online courses, and a mobile application. These tools will be made available through a single public portal to promote an efficient, ecosystem-based approach to fisheries management. The four-year project addresses the degradation of marine ecosystems and the anthropogenic impact caused by unsustainable exploitation of fisheries in several European seas to promote more efficient, holistic, sustainable and “ecocentric” fisheries

management that can restore the sustainability of fisheries and ensure greater balance between food, safety and healthy seas. The EcoScope platform will organize and homogenize climate, oceanographic, biogeochemical, biological, and fisheries datasets for European seas according to a common standard type and format that will be available to users through interactive mapping layers. This information will be presented to users through user-friendly interactive mapping layers. The international consortium will develop the EcoScope Toolbox, a scoring system linked to the platform, which will house ecosystem models, socio-economic indicators, fisheries and ecosystem assessment tools that will be used to examine and develop fisheries management and marine policy scenarios, as well as maritime spatial planning simulations. EcoScope will also apply new assessment methods for data-poor fisheries, including non-commercial species, as well as for biodiversity and conservation status of protected megafauna. This will include an assessment of the status of all ecosystem components in European seas and will test new technologies to assess environmental, anthropogenic and climate impacts on ecosystems and fisheries. Finally, tools such as online courses, films, documentaries, webinars and games will be available through the EcoScope Academy. The project consists of a partnership of 24 partners (universities, research institutions, NGOs, individuals) from Greece, Bulgaria, Germany, Canada, Israel, the Philippines, Spain, France, Belgium, United Kingdom, Portugal, Italy, Netherlands, Malta, Norway, Switzerland, and Cyprus, coordinated by the Aristotle University of Thessaloniki. CNR's participation in the project is coordinated by IRBIM CNR and includes the participation of the Institute ISTI CNR.



Baited video systems are part of a wider effort within the EcoScope project to develop new ways to collect data in order to fill in existing data gaps in marine research.

9.11.3.4 LIFE ELIFE

Project Full Title: Elasmobranchs Low-Impact Fishing Experience

Project Timeframe: September 1, 2021 - August 31, 2025

Institution(s): National Research Council (CNR)

Contact person: Alessandro Lucchetti and Sara Bonanomi

Link(s): https://www.irbim.cnr.it/en/progetto-dettagli/elife/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The ELIFE project aims to improve the conservation of elasmobranch species (sharks and rays) by promoting best conservation practices in European professional fisheries in the Mediterranean Sea by carrying out pilot and demonstration actions in Italian and Greek ports. Specific objectives of the project are:

- reduction in bycatch of many threatened elasmobranchs, critically endangered, endangered and vulnerable species, during professional fishing activities;
- reduction in mortality of threatened elasmobranchs during professional fishing activities;
- elimination of catches for the endangered shark Carcharhinus plumbeus caused by trawling in Lampione Island waters;
- reduction of incidental catch and collisions and anthropogenic disturbance on the endangered basking shark, Cetorhinus maximus, in the North Sardinian Sea;
- implementation of appropriate conservation measures with ecosystem approach to fisheries through the preparation and adoption of specific local management plans;
- support management authorities for shark conservation and management policies in IT and CY by providing more recent and in-depth data for environmental status assessment and implementing activities consistent with a management plan for this species.

9.11.3.5 PNRDA

Project Full Title: National program for the collection and management of biological, environmental, technical and socio-economic data for fisheries management

Project Timeframe: March 1, 2013 - July 31, 2025

Institution(s): National Research Council (CNR)

Contact person: Enrico Arneri

Link(s): https://www.irbim.cnr.it/en/progetto-dettagli/pnrda-national-program-for-fishery-data-collection/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: CNR IRBIM coordinates the National Program for Fishery Data Collection (PNRDA), conducted through a national partnership of research organizations, universities and private entities. Researchers belonging to the Institutes CNR IAS and CNR IREAalso participate in this Program. The PNRDA is formulated under the European Regulations establishing a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice relating to the Common Fisheries Policy (Data Collection Framework – Regulation (EU) 2017/1004). The basic purpose of this Program is to provide national and European administrations, as well as regional-level fisheries management bodies such as the General Fisheries Commission for the Mediterranean (GFCM) and the International Commission for the Conservation of Atlantic Tuna (ICCAT), biological, environmental, technical and socio-economic data and appropriate tools to undertake planning interventions and adopt management measures in line with the Common Fisheries Policy (CFP).

9.11.3.6 SISTEMA

Project Full Title: Environmental care as a lever of sustainable development

Project Timeframe: September 1, 2021 - August 31, 2024

Institution(s): National Research Council (CNR)

Contact person: Luca Bolognini

Link(s): https://www.irbim.cnr.it/en/progetto-dettagli/sistema/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: SISTEMA is a territorial project, coordinated by the Municipality of Ancona, dedicated to the protection, promotion and enhancement of land-sea ecosystems in the area of the city of Ancona and the Conero Park, understood as a flywheel for the growth of sustainable, inclusive and innovative economies and communities that make environmental care a lever for local productions capable of contributing to the achievement of the SDGs 11, 14 and 15 of the 2030 Agenda. The project will act within an ecosystem largely protected by a Nature Park and Natura 2000 sites established under the Habitats Directive, where production activities and urban settlements act within natural terrestrial and marine contexts subject to increasingly intense anthropization. Public administrations, Third Sector entities, associations, producers, economic activities and Research Centers participate in the project with the aim of redefining production, consumption, communication and relationship strategies with terrestrial and coastal environments in a sustainable way according to multiple and complementary activity directions: from land to sea; from sea to land; from man to man; from environment to man; from urban center to protected areas; from protected areas to the city. Along these lines, the project will organize its actions, which will cover the following areas: ecological conversion of production systems (organic farming and Small-Scale Fishery) and strengthening their aggregative and distributional capacity; tourism enhancement; environmental education and animation; and communication and information to citizens. The ambition is to support the growth of sustainable, responsible and aware communities through actions promoted by multi-actor partnerships, capable of guaranteeing measurable impacts and proposing innovative and scalable solutions both in the tools and methodologies adopted, keeping at the center of the project strategy, as the polar star of the SISTEMA, the ancestral relationship between land and sea on which the history and economy of this territory has been built. This generative approach will transcend the temporal boundaries of the project itself, thanks to an intense strategic as well as economic commitment on the part of the City of Ancona, giving rise to new systems of organization, production, fruition and enhancement that can continue and multiply in time and space the results obtained, providing opportunities for work, exchange and growth for the community as a whole. IRBIM CNR is contributing to the Project through research dedicated to the Small-Scale Fishery sector, encouraging the adoption of fishing practices and gears that have less impact on the environment, supported by scientific evidence and through the expertise available to the partnership. At the same time, it is planned to operate an awareness campaign and direct involvement of Small-Scale Fisheries operators with the aim of fostering the penetration of the proposed practices and techniques, up to the persuasion of operators about the advantages of their use.

9.11.3.7 DecarbonyT

Project Full Title: Decarbonisation of the fishing fleet in the Mediterranean and Black Sea

Project Timeframe: December 1, 2023 - November 30, 2025

Institution(s): National Research Council (CNR)

Contact person: Antonello Sala

Link(s): https://decarbonyt.eu/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The overarching aim of the DecarbonyT project (www.decarbonyt.eu) is to assess to what extent the use of optimized trawling gears in the Mediterranean and Black Sea can lead to lower fuel consumption and a more decarbonised fishing fleet. To fulfil this aim, the following main objectives have been defined:

1. to carry out, the development of a detailed literature review, and energy audits to establish baselines in the main trawl fisheries;
2. to launch of pilot projects for the testing of gear modifications, and;
3. the socio-economic analysis of the results emanating from said pilot projects;
4. to ensure the fishing industry, gear manufacturers, and relevant researchers are involved in this project.

This involvement is crucial for the uptake of the innovations tested in the pilot projects and consequently to the development of the socio-economic analyses emanating therefrom. Finally, showcasing the new types of fishing gears and their benefits, with stakeholders and Mediterranean (MEDAC) and Black Sea (BLSAC) Advisory Councils, is a key enabling factor to ensure a rapid uptake by the fishing sector. The project centres on towed fishing gears, with a focus on activities and innovations throughout the duration of the contract. In detail:

a) to review the latest gear technology advancements that have allowed for significant reductions in net drag and fuel consumptions as well as a compilation and critical review of best practices (Task 1), and;
b) to perform energy audit surveys to collect information and identify areas of possible intervention, on this basis;
c) to develop and test, through a minimum of 10 pilot trials, identified set of gear modifications that will allow reaching fuel consumption targets (Task 2);
d) to develop an economic analysis of the cost/benefits of adopting more fuel-efficient fishing gears (Task 3). These will allow for concrete results and create an impetus towards the development and adoption of new fishing gears to achieve energy-efficient and decarbonised fishing sector.
e) to ensure full engagement with the fishing sector (Task 4), fishing gear manufacturers and Mediterranean (MEDAC) and Black Sea (BLSAC) Advisory Councils to ensure the maximum dissemination of the sea trials and results.

9.11.3.8 RightFish

Project Full Title: Reducing environmental impact and greenhouse gas emissions in commercial fisheries

Project Timeframe: November 25, 2022 - November 25, 2025

Institution(s): National Research Council (CNR)

Contact person: Emilio Notti

Link(s): https://www.irbim.cnr.it/progetto-dettagli/rightfish/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: RightFish is developing generic methodologies to improve our ability to design and build low-impact towed fishing gears. The project advances the state-of-the-art in commercial fishing gear design by establishing criteria for small-scale modeling that incorporate the contact forces associated with towed fishing gear on the seabed. These approaches are tested in two case studies representative of European bottom trawling, demonstrating the environmental and economic benefits that can be achieved. These gears are more fuel-efficient, reduce disturbance of carbon-rich sediments, and minimize penetration into the seabed. Consequently, these gears ensure the sustainable management and harvesting of marine resources, preserving the integrity and resilience of the ecosystem while reducing greenhouse gas emissions. Additionally, these gears offer reduced fuel costs and can lead to increased fishing opportunities, improved market access and higher prices. Therefore, contributing to the sustainable production of blue bioeconomy. These gears enable the development of standards and processes that are transparent, certifiable and traceable, and may be used to gain customer's trust and increase market opportunities. The consortium includes industrial and academic experts in the design and development of commercial trawling gears, the evaluation of fishing gear technical and catch processes, and the environmental and socio-economic performance of fisheries.

9.12 Japan

9.12.1 Contact person

Yasuzumi Fujimori, Hokkaido University, fujimori@fish.hokudai.ac.jp

9.12.2 Summary

Hokkaido University is located at the northern tip of Japan and is characterized by fisheries research in temperate and subarctic waters. Many fishing technology researchers.

9.12.3 Projects

9.12.3.1 Monitoring the size of reared fish in aquaculture

Project Full Title: Using stereo cameras to monitor the body size of reared fish in net cage aquaculture

Project Timeframe: August 2021–March 2024

Institution(s): Faculty of Fisheries Sciences Hokkaido University

Contact person: Kazuyoshi Komeyama, komeyama@fish.hokudai.ac.jp; Yuki Takahashi, yukitakahashi@fish.hokudai.ac.jp

Link(s): https://researchmap.jp/gyogusekkei

https://researchmap.jp/yukitakahashi?lang=en

Summary: This study was carried out as a joint research project with companies in Japan. Key aquaculture management decisions, such as feeding regimes and harvest timing, depend on accurately assessing the size of the fish being reared. Stereo cameras have become a popular non-contact method of monitoring fish body size. Because stereo cameras are limited in their range and angle of view, it is important to understand the conditions necessary for their effective deployment in aquaculture net cages. Based on measurements from four stereo cameras installed at different depths in a net cage, we found that the numbers and body sizes of fish varied both temporally and spatially. A simulation of stereo camera measurements using a fish school behaviour model yielded differing results depending on the depth at which the cameras were installed. Accurate body size estimation was affected by fish stratifying into differing depths according to their size. Using a growth model based on the stereo camera body size measurements, we determined that the growth rate of farmed yellowtail varied seasonally. We conclude that the estimation of cultured fish body size via stereo cameras can be improved by understanding the swimming depths of reared fish and using growth models.

9.12.3.2 Automated seal detection in video image from monitoring of Kuril harbour seal invading a salmon set-net

Project Timeframe: September 2022 – April 2024

Institution(s): Faculty of Fisheries Sciences Hokkaido University, the Ministry of the Environment

Contact person: Yasuzumi Fujimori, fujimori@fish.hokudai.ac.jp; Tomiyasu Makoto, tomiyasu@fish.hokudai.ac.jp

Link(s): https:// https://www.researchgate.net/profile/Yasuzumi-Fujimori

https://researchmap.jp/tomiyasu/?lang=en

Summary: For the past six years, the monitoring of seals invading salmon set-nets via underwater cameras has been crucial for evaluating control measures for seals. Usually, the enumeration and temporal assessment of seal appearances have relied on manual video observation, consuming extensive time. This study aims to streamline this process by developing an automated application using deep learning-based image recognition techniques implemented through Python. Current results demonstrate a recognition rate exceeding 90%, averaged across the trial test

videos, which consist of a large number of short recordings. In future, we plan to evaluate the application on actual long-recorded videos.

9.12.3.3 Reducing set-net bycatch based on model simulations

Project Full Title: Reducing set-net bycatch based on simulations of fish swimming behavior

Project Timeframe: April 2020–March 2027

Institution(s): Faculty of Fisheries Sciences Hokkaido University

Contact person: Yuki Takahashi, yukitakahashi@fish.hokudai.ac.jp; Kazuyoshi Komeyama, komeyama@fish.hokudai.ac.jp

Link(s): https://researchmap.jp/yukitakahashi?lang=en

https://researchmap.jp/gyogusekkei

Summary: We propose a set-net configuration that can reduce the bycatch of non-targeted species based on simulations of fish swimming behavior. Set nets are among the most important fishing methods for small-scale fisheries in Japan. A set net is a passive type of trap that intercepts fish as they swim; because set nets are a passive form of fishery, bycatch can become a large problem because non-target species also enter the net. For example, limits have been set on the catch of young bluefin tuna, Thunnus orientalis weighing 30 kg or less, but it is difficult to prevent young bluefin tuna from entering a set net, and bycatch of young bluefin tuna has become problematic in the southern Hokkaido region. Another issue is that set nets can be very large, extending several kilometers, making it difficult to compare various net shapes in the actual ocean to assess their performance. To solve this problem, we simulated the set-net catch using a fish swimming behavior model that can reproduce schooling behavior in virtual space. Based on the simulation results, we propose a set-net shape that can reduce bycatch. These findings are expected to contribute to the conservation of non-targeted bioresources, while maintaining the profits of set-net fish harvesters.

Contact person

Taisei Kumazawa, taisei_kumazawa@nichimo.co.jp

Summary

Nichimo Corporation has several projects aimed at improving the recycling of fishing gear material

9.12.3.4 Aquaculture Net Cage Made from Recycled Fishing Nets

Project Full Title: Aquaculture Net Cage Made from Recycled Fishing Nets

Contact person: Taisei Kumazawa, taisei_kumazawa@nichimo.co.jp

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: Recycled fishing nets were developed from used polyethylene fishing nets. In Miyagi and Iwate prefectures in Japan, recycled fishing nets are used for aquaculture net cages for salmon. The use of recycled fishing nets reduces carbon dioxide emissions by about 15%. The aquaculture system with reduced environmental impact has been well received by salmon buyers.

9.12.3.5 Edible brown alga, Mozuku, Cladosiphon okamuranus Cultivation with Bio-Biodegradable Fishing Nets

Project Full Title: Edible brown alga, Mozuku, Cladosiphon okamuranus Cultivation with Bio-Biodegradable Fishing Nets

Contact person: Taisei Kumazawa, taisei_kumazawa@nichimo.co.jp

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: A plant-derived biodegradable fishing net was developed. Mozuku were cultured using plant-derived fishing nets in Okinawa, Japan. The results showed that growth of Mozuku was about four times higher with the plant-derived biodegradable nets than with the conventional petroleum-derived nets. Plant-derived biodegradable fishing nets emit less carbon dioxide during manufacture and combustion, and thus are expected to have less impact on accidentally eat marine organisms even if they are converted to microplastics. In addition, even in the event of a spill, the nets will biodegrade in the ocean over a long period of time, making them effective in mitigating ghost fishing.

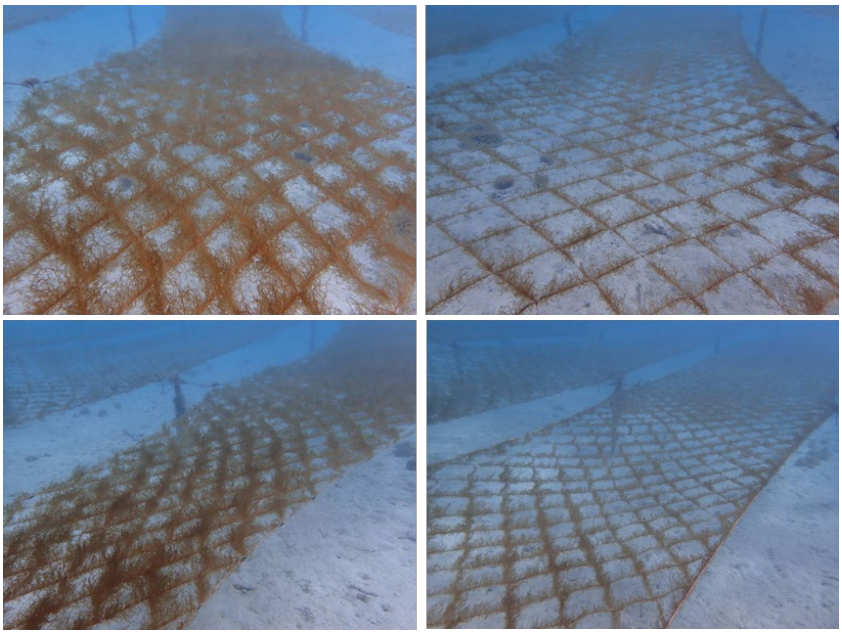


Figure 9.38. Plant-derived biodegradable fishing nets Conventional petroleum-derived non-degradable nets

9.12.3.6 Comparisons of Fishing Efficiency for Biodegradable Gill Nets and Conventional Nylon Gill Net

Project Full Title: Comparisons of Fishing Efficiency for Biodegradable Gill Nets and Conventional Nylon Gill Net

Contact person: Taisei Kumazawa, taisei_kumazawa@nichimo.co.jp

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: A biodegradable monofilament (made of PBAT) gill net was developed. Catch trials were conducted in Hokkaido, Japan, using biodegradable gillnets. The results showed that there was no difference in the catch of walleye pollock between the biodegradable gillnet and the conventional nylon gillnet, while the catch of herring was higher with the biodegradable gillnet. In addition, the catch of biodegradable gillnets was easier to remove than that of conventional nylon gillnets. The biodegradable gill nets are effective in mitigating ghost fishing and saving labor for gill netting operations.

Figure 9.39. Biodegradable monofilament (made of PBAT) gill net and fisheries exam boat

Contact person: Yoshiki Matsushita, Nagasaki University, yoshiki@nagasaki-u.ac.jp

Summary: Nagasaki University is located at the western end of Japan, close to China and Korea. It is characterized by research activities in the East China Sea, an international sea area.

9.12.3.7 Impact of benthic plastic debris on sessile organisms such as corals and seagrass beds

Project Full Title: Methods and technologies to understand the actual status of plastic debris on the seafloor and to support its recovery

Project Timeframe: April 2023 – March 2026

Institution(s): Tokyo University of Marine Science and Technology(PI), Nagasaki University, University of Tokyo, Japan Fisheries Research and Education Agency, National Institute of Environmental Studies

Contact person: Yoshiki Matsushita, yoshiki@nagasaki-u.ac.jp; Tadashi Tokai, Tokyo University of Marine Science and Technology, tokai@kaiyodai.ac.jp

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: This will be presented at the plenary session.

9.12.3.8 Technology to reduce bycatch of small fish in set-net fishing gear by using underwater lights

Project Full Title: Technology to reduce bycatch of small fish in set-net fishing gear by using underwater lights

Project Timeframe: April 2021 – March 2025

Institution(s): Nagasaki University, Yamaguchi Prefectural Fisheries Research Center

Contact person: Yoshiki Matsushita, yoshiki@nagasaki-u.ac.jp

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: As a method for mitigating bycatch of small fish of target species in set-net fishery, lighting outside a net at night to guide small fish in the net to pass through the mesh has been tested. In order to clarify the conditions that induce such behavior, aquarium experiments were conducted using small-sized individuals of horse mackerel, mackerel, and yellowtail.

Field observation of fish escaping from the net when an underwater light was turned on outside the set-net, was done by using an underwater camera and sonar.

Quantitative surveys will be conducted in this year.

Contact person: Keigo Ebata, Kagoshima University, ebata@fish.kagoshima-u.ac.jp

Summary

Kagoshima University is located in the southern part of Japan, and its strength lies in fisheries research in the subtropical to temperate waters. Several researchers in fisheries technology.

9.12.3.9 Seasonal variation of catch species and composition on stick-held dip net fisheries

Summary: Stick-held dip net fishing is a crucial method for capturing pelagic species including Japanese anchovy *Engraulis japonica*, round herring *Etrumeus teres*, and Japanese sardine *Sardinops melanostictus*. The operations of stick-held dip net fishing are conducted throughout the year in Kagoshima, Japan. The operating procedure is as follows: the fishing boats leave for the fishing grounds in the evening. Some fishing lamps are used to aggregate a fish school. The school is surrounded by a net and hauled up. The catch is transferred with a scoop net to a fish hold on the fishing boat. The catch is stored in the fish hold with ice and seawater until landing at the fish market. Fishing boats use significant amounts of fuel traveling from the pier to fishing grounds, searching for target species, and aggregating fish schools using the fishing lamps. The recent surge in oil prices has impacted fishery management. This study aimed to clarify seasonal variations in landing species and composition, operation sites, and fuel consumption of stick-held dip net fisheries to consider the measures and strategies for climate change and fuel price hikes.

All of the stick-held dip net fishery boats belonging to the Kitasatsuma Fisheries Cooperative located in Akune, Kagoshima land their catch at the Akune fishing port, and do not land at other fishing ports. Landing slips issued from 2020 to 2022 by the Kitasatsuma Fisheries Cooperative located at the Akune fishing port were obtained in Excel format to analyse the amount and composition of the fish landings of the surveyed fishing boats. The landing slips showed the names of the fishing boats and the landing weight for each fish species.

Peak of landing amount in 2020 was in October, while the peak landings in 2021 and 2022 were in September. Twenty fishing boats in total conducted the fishing operations from January to December 2022. The number of single day trips per month was 10 in January, then increased to 127 in May. The number of single day trips per month decreased to 119 in June, but increased again, peaking at 232 in August. However, from August onwards, the number decreased, reaching 13 in December. The average of landing amount per the single day trip was 821±299 kg in June, and then increased and reached a maximum in September with 3563±1525 kg. And then it declined from October, settling at 402±285 kg by December. The peak of landing amount for Japanese anchovy, round herring, and Japanese sardine was January, September, and September, respectively.

9.12.3.10 Estimating of fishing gear footprint of *gochi-ami* during the operation

Summary: Marine debris can settle and accumulate on the seabed due to several factors, such as weathering and biofouling, causing serious harm to the marine environment of fishing grounds and operation of fish harvest by the fishers. However, collection and removal of marine debris

are costly and labour intensive. The amount of marine debris accumulated in fishing grounds can be estimated based on the debris amount collected through the operations of coastal fisheries including *Gochi-ami* which is similarity to Danish seine and used by Japanese fishers. The area of seabed swept by fishing gear is necessary to examine the effects of the fishing on the seabed. In this study, time series changes of the distance, movement of the net on the seabed, net speed during towing, net mouth opening, and distance between the net wings of *Gochi-ami* were measured by using various sensors, and fishing gear footprint was estimated to determine the total amount of marine debris in the fishing ground in Eguchi, Kagoshima Prefecture, Japan.

This field study was conducted in July, 2023, during *Gochi-ami* operation on a 4.9-gross ton fishing boat (Juki-Maru). Two video cameras (HDR-AS50, Sony) were connected on the footrope to record the forward and backward movements of the net. Depth sensors (DST milli-F, Star-Oddi) were connected at the center of the headrope and footrope. The height of the mouth of the net was calculated from the difference between the headrope and footrope depths.

A current meter (ORI-PD3GT, Little Leonardo) was installed at the headrope center to record the speed of the net during towing. Acoustic transponders with a depth sensor (SDKN-600, Fusion Inc.) were installed on both ends of the wing nets to calculate their spread. A GPS logger (GT-600, Mobile Action Technology, Inc.) was also used to track the position of the fishing boat during the operations. Net speed and distance between the end of wing nets during towing were used to examine the fishing gear footprint.

The duration of bottom contact of the net was 6 min 19 s, and the net moved 39.1 m from the start to the end of towing. The net mouth and wing net openings were 28.9 m high and 49.8 m wide, respectively, at the beginning of the haul. However, by the end of the haul, the net mouth and wing net openings decreased to 16.4 and 28.4 m, respectively. Furthermore, the fishing gear footprint was calculated to be 1,730 m^2.

The findings of the present study indicate that the fishing gear footprint is crucial for estimating the total amount of marine debris accumulated in fishing grounds. To our knowledge, this is the first study on marine debris accumulation using *Gochi-ami* in Japan that aims to bridge the knowledge gap in current marine debris management in the fisheries sector and forms the basis for related future research.

9.12.3.11 Effectiveness of artificial seaweed as a habitat for puerulus larvae and juveniles of japanese spiny lobster panulirus japonicus

Summary: Japanese spiny lobster *Panulirus japonicus* are distributed from the Pacific coast, which is influenced by the Kuroshio Current and Tsushima Warm Current, to the Kyushu coast. *P. japonicus* is one of the most important fisheries resources in Japan. Owing to the high landing price of *P. japonicus*, the fishers have expressed a desire to increase the area of fishing grounds. Artificial reefs have been actively installed by local government of Kagoshima Prefecture to create new habitats for *P. japonicus*. However, the artificial reefs installed are designed to create habitats for adult of *P. japonicus*, and insufficient measures have been taken to create habitats for puerulus larvae and juveniles.

This field study aimed to clarify the effectiveness of artificial seaweed as a habitat for puerulus larvae and juveniles. The field survey was conducted in Uchinoura Bay, Kagoshima. The artificial seaweed (1.0 m long and 20 cm wide) employed in the study comprised three ropes attached with 10-cm-long and 4-mm-wide polyethylene/polypropylene mixed synthetic fibers, and it was equipped with a float at the top end and a metal fitting at the bottom end so that the seaweed was upright when placed in the sea. In Experiment 1, 16 artificial seaweeds were attached to the artificial reef on May 19, 2022, and four artificial seaweeds were retrieved on June 9, July 14, August 19, and October 24. In Experiment 2, eight artificial seaweeds were attached on May 19, and new artificial seaweeds were repeatedly retrieved and attached on June 9, July 14, August

19, and October 24; finally, all seaweeds were retrieved on November 30. The number of *P. japonicus* attached to the artificial seaweeds was counted, and body length were measured.

Puerulus larvae were found on artificial seaweeds on June 9, July 14, and August 19 but not on October 24 and November 30. The number of puerulus larvae per artificial seaweed was 0.3, 0.9, and 0.1, respectively, reaching a maximum in August. Juveniles were found on the artificial seaweeds on June 9, July 14, August 19, and October 24 and but not on November 30. The number of juveniles per artificial seaweed was 0.3 and 0.6 on June 9 and July 14, respectively, and it decreased to 3.1 on August 19 and 0.2 on October 24. The body length of the puerulus larvae was 18.8 ± 0.3 and 22.0 mm on June 9 and August 19, respectively. Moreover, the body length of the juveniles increased from 19.9 ± 0.7 mm on June 9 to 27.4 ± 0.5 mm on October 24. As a result of the field survey, the installation of artificial seaweeds is considered to be effective in creating habitats for puerulus larvae and juveniles of *P. japonicus*.

9.13 Northern Ireland

9.13.1 Contact person

Ben Collier

- Northern Ireland Gear Trials Project, Northern Ireland Fishermen's Federation (NIFF), ni-geartrials@outlook.com

9.13.2 Summary

- The Northern Ireland Gear Trials Project is an industry led initiative that collaborates with the Department of Agriculture, Environment & Rural Affairs (DAERA), the Agri-Food & Biosciences Institute (AFBI) & Seafish.
- The aim of our work is to design, trial and implement more selective fishing gears for the purpose of reducing & eliminating unwanted catch in the Irish Sea nephrops fishery. We also work with fishermen to identify and trial novel approaches to reduce fuel use/ emissions and minimise gear/ seabed interactions.

9.13.3 Projects

9.13.3.1 Project: Gear Trials Partnership Project

Project Full Title: Gear Trials Partnership Project

Project Timeframe: October 2023 – March 2025

Institution(s): MarFishEco, Northern Ireland Fishermen's Federation, Agri-Food & Biosciences Institute, Seafish, D. McClements, P. Clark.

Contact person: Andrew Johnson, andrew@marfisheco.com Lois Flounders, lois@marfisheco.com Ben Collier, ni-geartrials@outlook.com

Link(s): FISP projects: contracts awarded in round 4 of the scheme - GOV.UK (www.gov.uk)

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The Gear Trial Partnership Project (GTPP) will robustly trial and make final conclusions on the performance of two highly selective trawls designed for use in the UK Nephrops

fishery - the dual codend (Figure 9.40) and coverless trawl (Figure 9.41). By working with industry, management, and policy from day one, results from the two-year GTPP will feed directly into practical fisheries management through technical measure regulation to improve the efficiency and sustainability of the UK Nephrops fleet and the profitability of associated supply chains.

To date, trials of both trawls have been undertaken onboard commercial fishing vessels operating in the Irish Sea and North Sea during Autumn 2023 and Spring 2024. Final trials will be undertaken in Autumn 2024. Final report will be available in early 2025.

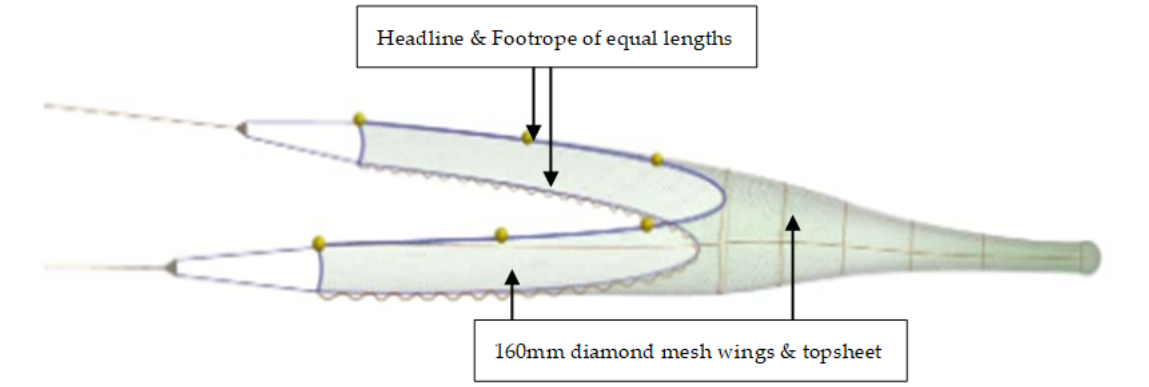


Figure 9.40. Dual codend trawl - Key features.

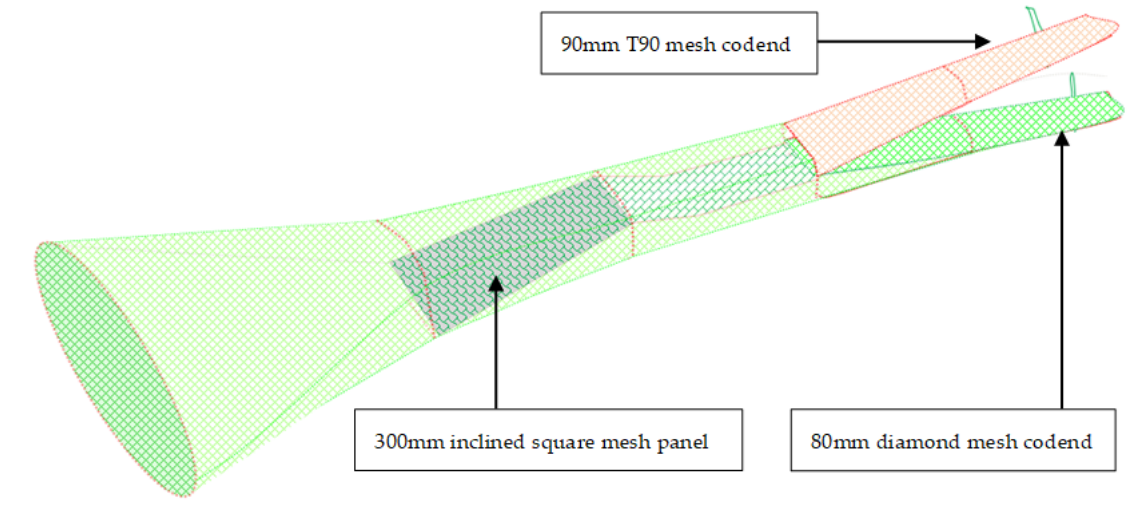


Figure 9.41. Coverless trawl - Key features.

9.13.3.2 Project: Trawl Door Testing - Hirshals Flume Tank

Project Full Title: Trawl door testing for reducing fuel use and seabed contact.

Project Timeframe: November 2023

Institution(s): Northern Ireland Fishermen's Federation, Seafish, Bord Iascaigh Mhara, Polar Doors.

Contact person: Ben Collier, ni-geartrials@outlook.com

Link(s):

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Performance assessments of different trawl doors used in combination with the design of nephrops trawl that is commonly used by Northern Irish vessels were undertaken during a two-day trip to the flume tank in Hirtshals, Denmark.

It was confirmed that Thyboron semi - pelagic trawl doors (Figure 9.428a) can be used in combination with a nephrops trawl without compromising trawl efficiency. An >12m twin rig nephrops trawler within the local fleet is already using this system. Observations of the same set up in the flume tank were useful in demonstrating to the group that this approach to fishing is a viable option.

Polar Pluto trawl doors (Figure 9.42b) were also tested in combination with a standard Northern Irish nephrops trawl. It was also confirmed that this type of door works well without lifting the footrope off the bottom.

Measurements of warp tension (Table 9.2) indicated that the traditional V - door (Figure 9.42c) creates more drag than other types of trawl door. The Polar Pluto doors produced the least amount of drag when used on the bottom with Thyboron demersal doors (Figure 9.42d) also producing less drag than the V - doors.

Future work will aim to replicate some of the research carried out at the tank under commercial fishing operations.

The main purpose of this trip was to investigate the viability of different approaches to fishing operations and new trawl door technologies that have the potential of contributing towards the fishing industries carbon emission reduction and net zero commitments. In addition, this research was aimed at investigating approaches that have the potential to reduce interactions between trawl doors and the seabed. The focus of the two days was on nephrops trawl gear typical to the Northern Ireland fleet.

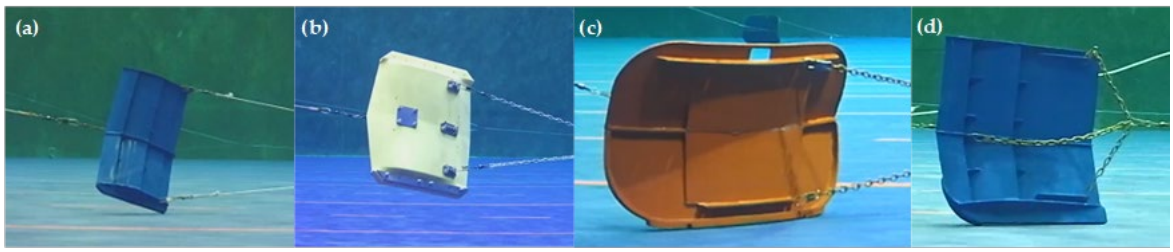


Figure 9.42. (a) Thyboron semi-pelagic, (b) Polar Pluto, (c) V - door, (d) Thyboron demersal

Table 9.2. Results of warp tension measurements obtained during tank testing.

Door Type	Door Spread (m)	Footrope Spread (m)	Headline Spread (m)	Drag per side of trawl (t)	Drag attributable to doors only (t)	Percentage of total drag attributable to doors only (t)
V Door	44.00	15.80	12.10	1.87	0.47	25.13
Thyboron demersal	50.00	17.20	13.20	1.67	0.27	16.17
Pluto doors on bottom	51.00	17.40	13.00	1.60	0.20	12.50

Pluto doors 4.5m off bottom	51.20	16.80	13.30	1.77	0.40	22.59
Pluto doors 2.2m off bottom	-	-	12.60	1.76	0.36	20.45

9.13.4 Future projects and Ideas

9.13.4.1 Project: Northern Ireland Gear Trials Project

Project Full Title: Relocation/ Redesign of 300mm square mesh panels on quad - rig nephrops trawler

Estimated Project Timeframe: March 2024 – August 2024

Institution(s): Northern Ireland Fishermen's Federation, Department of Agriculture, Environment & Rural Affairs, Agri-Food & Biosciences Institute.

Contact person: Ben Collier, ni-geartrials@outlook.com

Link(s):

Collaboration welcome?: NA

Funding secured?: N

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: A Northern Ireland based quad - rig nephrops trawler has been fishing under a six-month dispensation since March 2024. The dispensation relates to the relocation of two square mesh panels (SMPs) on two of the vessels four nets for the purpose of improving the avoidance/ release of <MCRS whiting and other gadoid fish species.

The relocated SMPs measure 2m x 2m (as opposed to the standard 3m long, rectangular shaped SMPs). The SMPs that have been relocated/ redesigned are located on the middle port and port nets. The middle starboard and starboard nets SMPs will remain unaltered (Figure 9.43).

The rationale for this request is supported by catch results from gear trials undertaken onboard another Northern Irish nephrops trawler in 2008. During this work a 65% reduction in whiting catch was achieved when the SMPs were situated further forward in the trawl than their current position. In addition, more recent gear trials that have been managed under the Northern Ireland Gear Trials Project have indicated that modifications in the front end of trawls work well at reducing unwanted catch of the type that is typical of the Irish Sea nephrops fishery.

During the six-month dispensation period some fishing trips will accommodate a scientific observer. Other observations of the catch are also being recorded. At the end of the six-month period, due to finish in August 2024, the project steering group will undertake a review and consider a fully chartered gear trial with this vessel.

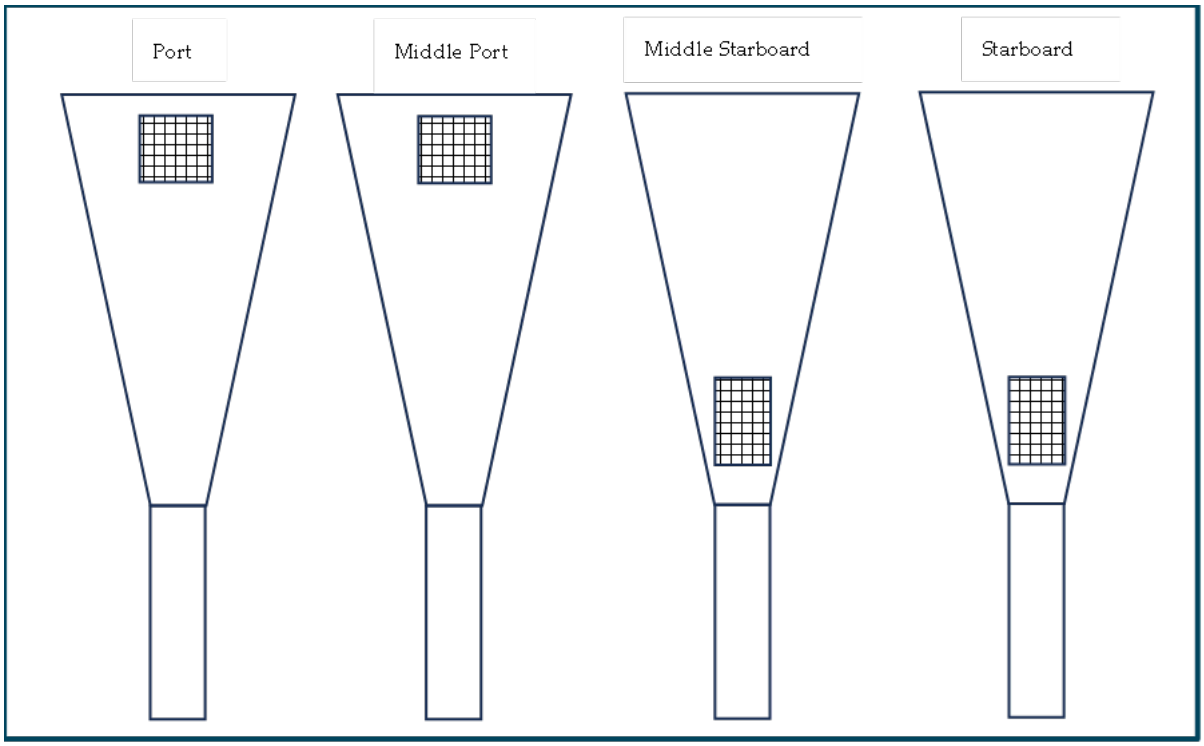


Figure 9.43. Plan showing standard position of SMPs on starboard and middle starboard nets and relocated position of SMPs on the middle port and port nets.

9.13.4.2 Project: Improved Estimates of Bottom Contact and Recovery

Project Full Title: RESONANCE - Improved estimates of bottom contact and recovery

Estimated Project Timeframe: January 2023 – Augst 2025

Institution(s): Ulster University, Northern Ireland Fishermen's Federation, Agri-Food & Biosciences Institute, Alaska Pacific University, Cornell University, University of Limerick, Fisheries Inshore New Zealand, Zebra Tech

Contact person: Chris McGonigle, cd.mcgonigle@ulster.ac.uk

Link(s) FISP projects: grants and contracts awarded in round 2 of the scheme - GOV.UK (www.gov.uk)

Collaboration welcome?: NA

Funding secured?: Y

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The Ulster University and the Northern Ireland Fish Producers Organisations project is based on the application of seafloor mapping & fishing gear sensor technologies to better understand the interactions between commercial fishing gear and nephrops habitat. The project encompasses a team of scientists, engineers, and fishing industry with expertise in marine robotics, seafloor mapping, fisheries impacts and gear technology.

The aim of this work will be to understand how fishing gear interacts with the seabed using a combination of technologies including contact sensors attached to the footrope of a towed

nephrops trawl (Figure 9.44 and Figure 9.45), high-frequency seafloor acoustics and towed video arrays. The footrope sensors will allow in situ, empirical data to be collected on gear/ seabed contact as opposed to the standard approach that is used to estimate trawl footprint.

The community outreach component of this project has been completed. Due to problems with the Ulster University research vessel the field work component of the project has been delayed. Fieldwork is planned for the summer period of 2024.

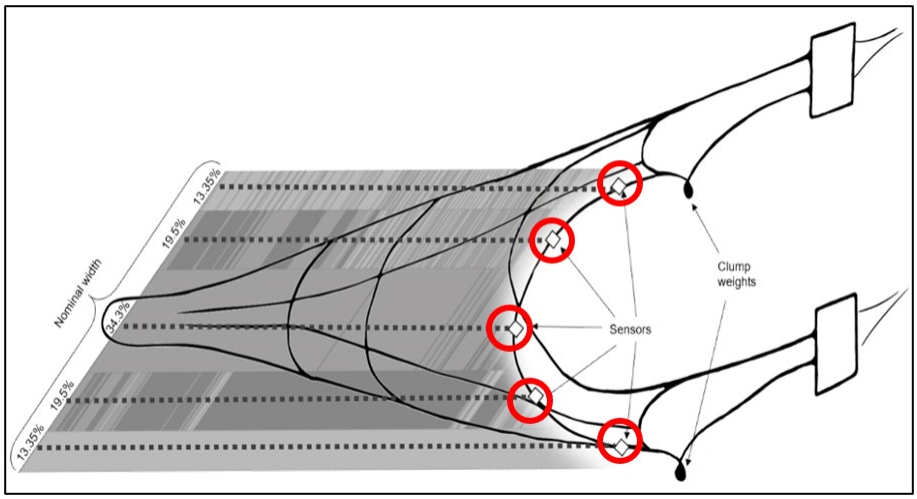


Figure 9.44. Position of contact sensors on trawl footrope & sensor output.

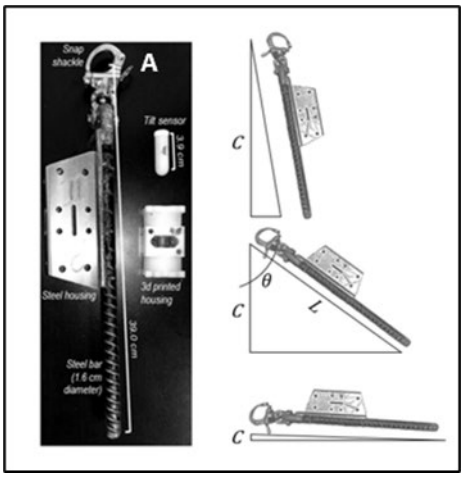


Figure 9.45. First generation footrope contact sensors.

9.14 Norway

9.14.1 Contact person

- Svein Løkkeborg, Institute of Marine Research, svein.lokkeborg@hi.no

9.14.2 Summary

- Bycatch of seabirds in purse seine fisheries
- By-catch of whales in purse seine fisheries

- WP3 Ground truthing acoustic data (CRIMAC)
- Development of environmentally friendly pot fishing for snowcrab
- Development of selectivity systems for gadoid trawls
- Sustainable catch and live storage of bluefin tuna in Norway
- Catch limitation in the blue whiting pelagic trawl fishery
- New knowledge and technology for sustainable capture of pink salmon
- CRI Dsolve - Biodegradable plastics for marine applications - Centre for research-based innovation.

9.14.3 Projects

9.14.3.1 By-catch of seabirds in purse seine fisheries

Project Full Title: By-catch of seabirds in coastal purse seine fisheries – magnitude and mitigation measures.

Project Timeframe: May 2022 – April 2024

Institution(s): Norwegian Institute for Nature Research (NINA), Institute of Marine Research

Contact person: Maria Tenningen, maria.tenningen@hi.no / Signe Christensen-Dalsgaard, Signe.Dalsgaard@nina.no

Link(s): https://www.fhf.no/prosjekter/prosjektbasen/901751/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This project aims to get a better understanding of by-catch incidents of seabirds in the coastal purse seine fishery for Norwegian spring spawning herring. The aim is to estimate how often by-catch incidents occur, what the processes leading to by-catch are and develop mitigations measures (e.g. light, sound, visual objects). The project started in May 2022. We have now completed the field work and are working with analyses and reporting. In the field, we used a combination of light sensitive camera systems and IR binoculars to monitor the birds in the dark winter nights in the Northern Norway. Birds in the net were exposed to light and sound signals and their reactions registered. The number of seagulls present varied greatly between sets. A few by-catch events were registered. Seagull by catch in the herring fisheries seems to be a rare evet, but at times large numbers are caught. Therefore, the mitigation methods should be easy to use and low cost. Our preliminary results indicate that sound signals efficiently scare the birds out of the net for short periods.

9.14.3.2 By-catch of whales in purse seine fisheries

Project Full Title: Identification and testing methods to reduce interactions between fisheries and whales.

Project Timeframe: July 2021 – June 2026

Institution(s): Institute of Marine Research, Arctic University of Norway, University of St. Andrews

Contact person: Maria Tenningen, maria.tenningen@hi.no, André Moan, andre.moan@hi.no

Link(s): https://www.fhf.no/prosjekter/prosjektbasen/901681/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: During winter a large part of the Norwegian spring spawning herring stock gather in the northern Norwegian fjords. The herring are targeted by the coastal purse seine fleet and attract large numbers of whales, mainly humpback and killer whales. The whales tend to aggregate around the fishing boats and feed on the herring escaping the nets. At times whales get entangled in the net, often leading to damaged nets that are costly and time consuming to repair and / or the whale may drown and die. This project aims to use sound to deter the whales from interacting with the fisheries. The aim is to test and develop sound that elicit an autonomous reflexes associated with the flight response. The first task was to tag killer and humpback whales and monitor their startle responses to different sound signals under controlled conditions. The second task was to expose whales to the species-specific sounds during commercial fishing. The project has successfully developed sound signals that keep killer whales away from the nets. For humpback whales further work is required. We have also tested effects of sound signals on herring with no observed reactions. The sound signals are within the hearing range of herring and could therefore affect their behaviour and interfere with the fishing process. As part of the project, we also consider practical implementation of the sound systems to commercial fisheries.

9.14.3.3 WP3 Ground truthing acoustic data (CRIMAC)

Project Full Title: WP3 ground truthing methods for acoustic data in the CRIMAC center for research-based innovation

Project Timeframe: November 2020 – November 2028 (depending on midway evaluation in 2024)

Institution(s): Institute of Marine Research, Kongsberg Maritime AS, Scantrol Deep Vision, Eros AS, Libas AS, University of Bergen

Contact person: Maria Tenningen, maria.tenningen@hi.no, Nils Olav Handegard, nilsolav@hi.no

Link(s): https://crimac.no/en/projects/crimac

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: CRIMAC is a center for research-based innovation that aims to improve and automate the interpretation of data and images from modern broadband acoustics in marine research and fisheries. The center has 6 work packages where WP3 “ground truthing methdos” aims to develop and implement techniques for identifying and measuring sources of broadband backscatter. The focus is currently on further development of in-trawl camera systems including data processing and flow, implementation in routine fish stock surveys and development to commercial fisheries. The work done is in close cooperation with the industry partners.

9.14.3.4 Development of environmentally friendly pot fishing for snowcrab

Project Full Title: Development of environmentally friendly pot fishing for snowcrab

Estimated Project Timeframe: 2020- 2023

Institution(s): Institute of Marine Research

Contact person: Odd-Børre Humborstad, oddb@hi.no, Svein Løkkeborg, svein.lokkeborg@hi.no, Terje Jørgensen, terje.joergensen@hi.no, Neil Anders, neil.anders@hi.no, Olafur Arnar Ingolfsson, olafur.arnar.ingolfsson@hi.no

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? Yes

Summary: The project consisted of four work packages and conducted a combination of laboratory behavioral experiments and fishing trials in the field (Humborstad et al 2023 (in Norwegian) https://www.hi.no/hi/nettrapporter/rapport-fra-havforskningen-2023-51) In Work Package 1 ("Increasing catch efficiency for crabs above the minimum size"), it was demonstrated that using smaller mesh sizes in pots increased the catch of all size groups of crabs. In Work Package 2 ("Efficient selection of sub-legal sized crab at the fishing depth"), it was shown that escape openings effectively reduced catches of sub-legal sized crab, but also resulted in loss of legal-sized crab ((Anders et al 2022 https://doi.org/10.1016/j.fishres.2022.106517). The openings could also be easily obstructed by large crabs. The base of the pots selectively released a significant amount of catch on the way to the surface, indicating a potential for further improvements through alternative bottom designs. Plastic collars designed to prevent sub-legal sized crabs from accessing the pot's top entrance were ineffective, as crabs easily grasped any irregularities in the collar and climbed over the obstacle. In Work Package 3 ("Escape openings for lost pots") various thicknesses of biodegradable cotton twine was tested during commercial fishing. Cotton twine was found to be the simplest method to prevent ghost fishing when pots are lost. Standardization of cotton thread was explored through several tensile tests, different diameter measurement methods, and the inclusion of Rtex (linear density, units: g / 1000 m of twine) as a descriptor for the quality of twine. In Work Package 4 ("Subsea buoy with acoustic release ["IceCatcher"]") several successful functional tests were conducted aboard research vessels. Further tests under commercial fishing conditions and real ice conditions are still required. Overall, the project has made significant contributions to our understanding of the efficiency and selectivity in snow crab pots. A key conclusion is that the pot design used commercially currently represents the best balance between efficiency and selectivity. The work on biodegradable twine has been incorporated into formal advice from the Institute of Marine Research. Biodegradable twine was made mandatory for the 2024 season.

9.14.3.5 Development of selectivity systems for gadoid trawls

Project Full Title: Development of selectivity systems for gadoid trawls

Project Timeframe: October 2020 – June 2024

Institution(s): Institute of Marine Research, Arctic University of Norway, SINTEF Ocean

Contact person: Manu Sistiaga, manu.sistiaga@hi.no

Link(s): https://www.fhf.no/prosjekter/prosjektbasen/901633/

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The project "Development of selectivity systems for gadoid trawls" aims at improving exploitation patterns of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*) in the Norwegian Sea and Barents Sea bottom trawl fisheries. Between October 2022 and November 2023, the last three studies in the project were conducted. The first and third studies were carried out in a commercial vessel whereas the second study was carried out onboard the research vessel R/V Helmer Hanssen. All three cruises were conducted off the coast of northern Norway and in the Barents Sea.

Cruise 1, used versus new grid sorting system: Earlier selectivity studies with the flexigrid sorting grid system device have shown inconclusive results. It has been speculated that the

differences observed resulted from the difference in age and usage of the grid sections in the studies compared. To reveal whether potential changes in the device construction over time can lead to differences in size selection properties, we performed comparative fishing trials where we compared a brand new flexigrid section and a well-used flexigrid section used continuously by a commercial trawler for approximately four years. The results showed that the new flexigrid released significantly more cod below ~60 cm than the used flexigrid. However, when the grids were fished with a subsequent diamond mesh codend, there was no difference in the overall selectivity of the two gears, meaning that the size selectivity in the codend compensates for the potential reduction in selectivity performance of the grids. This study shows the importance of considering the age and earlier use of size selection devices like sorting grids before they are compared with other devices, as their size selection properties can change significantly over time and with use.

Cruise 2, tests with sorting devices with different rigidness: In the present study, we tested and compared the size selectivity performance of two "diamond-mesh codend designs" in the Barents Sea gadoid trawl fishery: a four-panel codend, which was more rigid than a traditional two-panel codend design due to the additional selvedges, and a fully rigid codend design, that included a metal frame. The aim was to investigate the effect of added codend rigidness on the size selectivity of cod (Gadus morhua), haddock (Melanogrammus aeglefinus) and redfish (Sebastes spp.). In addition, the obtained results were compared to earlier research on size selectivity in this fishery including codends with different levels of rigidness and sorting grids. The results demonstrated that using a fully rigid codend did not result in a sharper size selectivity compared to a four-panel codend. Further, there was no indication that a rigid sorting grid makes size selectivity sharper than what can be obtained with a four-panel diamond mesh codend alone. There was also no proof that other codend stabilizing mechanisms such as shortened lastridge ropes could make the size selection sharper compared to the four-panel codend.

Cruise 3, tests with an upscaled sorting grid system: The upscaling and development of the trawl gear operated in the Barents Sea in the last three decades has contributed to capacity issues that can lead to inefficiencies in size selectivity and operational problems like the burst of grid sections. The present study investigated whether upscaling a Sort-V grid section by doubling its sorting area would improve the size selectivity of the gear in the fishery compared to a standard Sort-V grid section. The results showed that the upscaled grid significantly increased the sorting efficiency of the grid undersized haddock (*Melanogrammus aeglefinus*), while the catch efficiency of commercial-sized cod (*Gadus morhua*) and haddock were equally efficiently retained. The additional sorting capacity exhibited by the upscaled grid section is expected to play an important role for the future management of the fishery. Further, it demonstrates the importance of revising the efficiency of compulsory selectivity devices periodically and can point to the direction to adopt in other fisheries with similar issues. The upscaled grid did not imply any additional work or challenge for the crew during its operation.

Figure 9.46. Pictures of a grid in the new flexigrid section (a), a grid in the used flexigrid section deformed on deck (b), and a grid in the used flexigrid section laying on deck (c).

9.14.3.6 Sustainable catch and live storage of bluefin tuna in Norway

Project Full Title: Sustainable catch and live storage of bluefin tuna in Norway

Project Timeframe: January 2022 – June 2024

Institution(s): Institute of Marine Research, NOFIMA, Polytechnical University of Valencia

Contact person: Manu Sistiaga, manu.sistiaga@hi.no

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Norway was historically a major bluefin tuna (BFT) harvesting country (Thunnus thynnus). Following a moratorium enforced in the 80ies, the fishery was reopened in Norway in 2014. However, fishing for this species has experienced low profitability. One potential solution is short-term live storage so that the market can be supplied on demand. Short-term live storage of BFT leads in addition to physiological recovery of the fish and allows a more controlled slaughtering of the fish, resulting in better quality and fish welfare. While live storage of BFT is a well-stablished activity in many countries around the Mediterranean and other parts of the world, it has never been practiced in Norway prior to this project.

The present project comprises of activities conducted during 2022 and 2023 in a pilot project established by the Institute of Marine Research and the Directorate of fisheries to address knowledge gaps related to BFT live-storage in Norway. Two cruises were carried out during the project period with the aim of developing methods and testing equipment to achieve sustainable catch and live storage of BFT in Norway. The first cruise was characterized by the lack of catches of BFT while in the second cruise a total of 28 fish were transferred for the seine to a transfer cage in three different casts. Three fish from the last cast were transferred from the transport cage to a stationary cage located by the coast proving for the first time that live storage of BFT is possible in Norway.

The results of the project corroborated that the purse seine BFT fishery in Norway has low profitability the way it is carried out today and that live storage can be an alternative to make the fishery more valuable. However, if live storage of BFT is to be established as a profitable activity in Norway in the near future, challenges within the following issues need to be solved:

• Fish identification, fish capture and catch control, i.e., precision of acoustic and optical monitoring systems to harvest BFT efficiently and control of the catch.

• Transferences of fish, i.e., improvement of gear for more efficient transferences with better preservation of fish welfare as well as monitoring to achieve compliance with ICCAT regulations.

• Fish welfare and quality, i.e., development of low-stress and humane slaughter methods that promote good welfare and quality.

• Live storage, i.e., establish minimum feeding requirements and temperature thresholds for live-stored BFT in addition to the creation of infrastructure and logistics necessary in the activities associated to live storage of BFT.

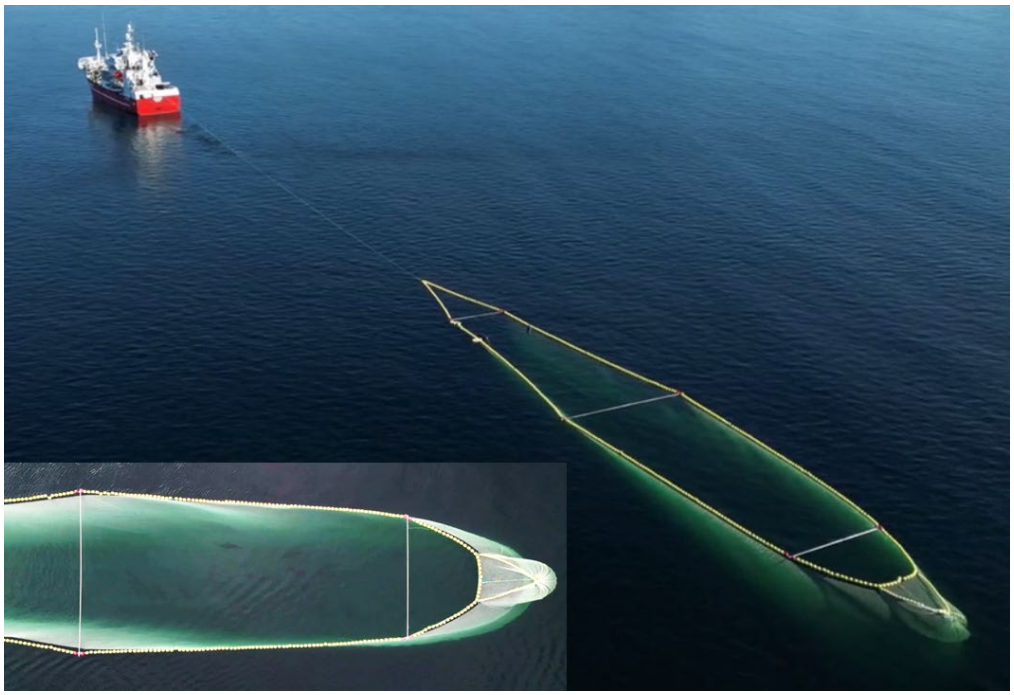


Figure 9.47. Transport of live BFT caught in Norwegian waters.

9.14.3.7 Catch limitation in the blue whiting pelagic trawl fishery

Project Full Title: Catch limitation in the blue whiting pelagic trawl fishery

Project Timeframe: Jan 2019 – Jun 2025

Institution(s): Institute of Marine Research, Norwegian Directorate of Fisheries

Contact person: Ólafur A. Ingólfsson, olafur@hi.no

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: In the pelagic fishery for blue whiting (*Micromesistius poutassou*), catches are usually measured in hundreds of tonnes. There have been frequent incidents of burstet codends and it is difficult to fill the vessels accurately. The main objectives in the project are thus to develop and

implement a catch limitation device to set a maximum capacity for the codend. A device was tested, with large meshes in the bottom panel in front of the codend and smaller openings in top and bottom. A fish lock is mounted behind the large openings to avoid spillage of fish during haulback. The codend is choked to determine its maximum volume, and automatic releaser fittet to release the choking during ascent, adjusted to release at 100-150 m depths (Figure 9.48).

The solution proved to be successful, with negligible loss of fish before the codend was full. Two types of releasers were tested, one electronic and one mechanical. Unfortunately, the release mechanic was to weak to unchoke the codend during haulback. Ongoing work aims mainly at measuring the strain on the release hook and improving the the release mechanism. The fish lock also needs some considerations.

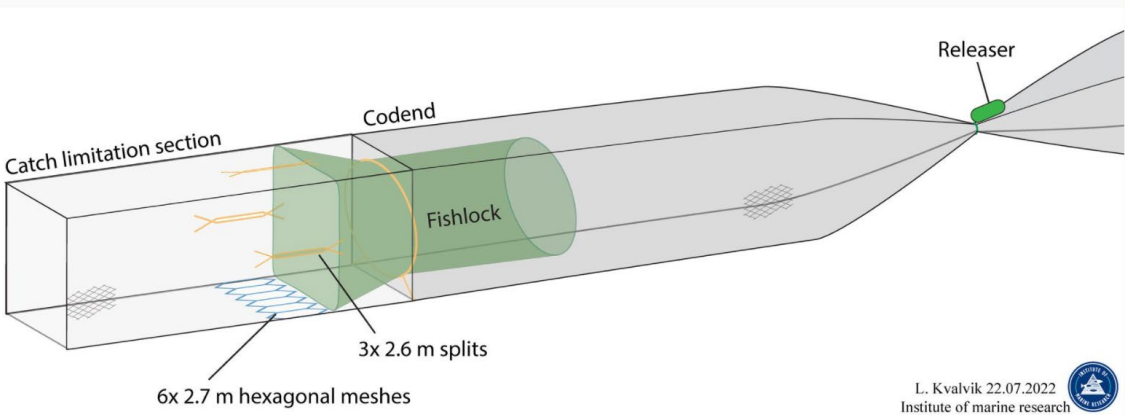


Figure 9.48. The catch release system illustrated. Catch limitation section with openings and fish lock. Codend releaser for choking the codend to set a maximum desired volume.

9.14.3.8 Pink salmon

Project Full Title: New knowledge and technology for sustainable capture of pink salmon

Project Timeframe: June 2023 – December 2025

Institution(s): Institute of Marine Research, Møreforsking

Contact person: Svein Løkkeborg, svein.lokkeborg@hi.no, Wenche Emblem Larssen, wenche.emblem.larssen@moreforsking.no

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Pink salmon (Oncorynchus gorbuscha) is an introduced species in Norwegian waters. Efforts are in place to reduce the abundance and distribution of this invasive species. The objective of this project is to design and test a pound net (trap-net) to effectively catch pink salmon in the sea and allow benign release of bycatch of protected salmonids. A gear based on the pound net used for catching Atlantic salmon has been design and constructed. The gear has one chamber to which a cage (net pen) is attached. Pink salmon caught in the cage can easily be collected and slaughter to achieve a high-quality product for human consumption. Furthermore, bycatch of other salmonids can be released in a gentle way. The performance and catch efficiency of this pound net will be tested during the summer season in 2025.

9.14.3.9 CRI Dsolve

Project Full Title: CRI Dsolve - Biodegradable plastics for marine applications - Centre for research-based innovation.

Project Timeframe: November 2020 – December 2028

Institution(s): Scientific institutions: UiT the Arctic University of Norway (lead), Norner, SINTEF Industry, SINTEF Ocean, NORUS, DTU Aqua, Thünen Institute of Baltic Sea Fisheries, University Split. Industry partners: LG Chem, S-EnPol, Øra, Legøy rederi, Marin Solhaug, Loran, Opilio, Tustern, Hermes, Kvarøy fiskeoppdrett, SalMar, Nofi Tromsø, Mørenot, Løvold, Mustad Autoline. (Industry partners represent material production, gear suppliers, fishing vessels operating line and hooks, gillnets, pots, demersal seines, bottom trawls and components for aquaculture).

Contact person: Roger B. Larsen, roger.larsen@uit.no

Link(s): https://dsolve-sfi.no/en/om-dsolve

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? Yes

Summary: Centre for Research-based Innovations (CRI) Dsolve started late 2020 and is planned to end in the end of 2028. The centre is funded by the Research Council of Norway and a number of partners from science and industries. The main focus for Dsolve is to reduce marine littering and negative impacts on all marine life caused by ALDFG (Fig. 1) by replacing conventional plastics with biodegradable materials in fishing and aquaculture industries. The Dsolve team is built from eight research partners, 15 industry partners and eight partners in advisory committees. The conceptual structure of the CRI Dsolve is shown in Fig. 2.

The main objective of CRI Dsolve is to reduce plastic litter and its associated problems such as macro- and microplastics and ghost fishing in the marine environment caused by fishing and aquaculture industries, by replacing the traditional plastics used in gears and gear components with new biodegradable materials. This primary objective will be achieved by accomplishing the following secondary objectives:

• Develop new smart biodegradable polymers with controllable (non-linear) degradation in the marine environment.

• Develop biodegradable filaments, twines, ropes, and netting for fisheries and aquaculture purposes.

• Create governmental incentives and restrictions to incorporate biodegradable plastics in an ecosystem-based management approach.

• Help to establish a supplier industry that can deliver biodegradable gears and services to the end-user sectors (fisheries and aquaculture).

• Develop sustainable downstream solutions and LCA for biodegradable fishing gear.

• Optimize and validate waste sorting technologies and circular waste processing options for biodegradable materials.

Recent outcomes: Most of the work by our partners has been directed towards gillnet, longline, demersal seine, and bottom trawl fisheries. New types of biodegradable materials for components like codend chafing mats ("dolly ropes") in bottom trawls were made during March 2023. Experiments to examine ghost fishing with self-baited snow crab pots were conducted in the northeast Atlantic and trials with bottom trawls focusing on ground rope were performed during

experiments in the central Barents Sea by December 2023. Additional samples of various materials have been placed at a depth of 80 m close to Tromsø for long term examination of biofouling and degradation processes. Basic research in laboratories by our partners to identify properties of existing materials and new resins for the use in fishing gears, is a continuing process.

Fishing gears like gillnets and sections of longlines, i.e. snoods, and protecting chafers in bottom trawls and herding ropes of demersal seines contribute much to the marine littering from fisheries. Samples from the tested gears in Croatia, Germany, Denmark, and Norway, undergo long term experiments to calculate degradation from various marine environments.

Future prospects: Our industry partner LG Chem in South Korea have produced new types of biodegradable polymers for fibre production based on PBSA (polybutylene succinate-co-adipate), that more closely resembles the important properties of nylon like elasticity and tensile strength than the former PBSAT material. The latest PBSA gillnet experiments in Norway showed that improvement in catchability compared to PBSAT.

We will continue experiments with longline, gillnets, demersal seine and pots during 2024 and onwards. All research areas of Dsolve are active in producing results, and currently seven PhD/post.doc positions are attached to the CRI. Two of our seven are studying incentives for acceptance of biodegradable fishing gears, and we will strengthen the focus on open ocean fish farming. We will participate in the annual recovery mission og ALDFG organised by the (Norwegian) Directorate of Fisheries and include scientists and students in the work.

On the Dsolve webpage more and updated information is given in newsletters, partner presentations, podcasts, videos, SoMe and annual reports.

Figure 9.49. Examples of ALDFG recovered from fishing grounds in the northeast Atlantic. Snow crab pots (left) and a very old gillnet (right) with dead, degraded and fresh caught animals. Photos: Snow crab pots: Bjarni Petersen and gillnet: Roger B. Larsen.

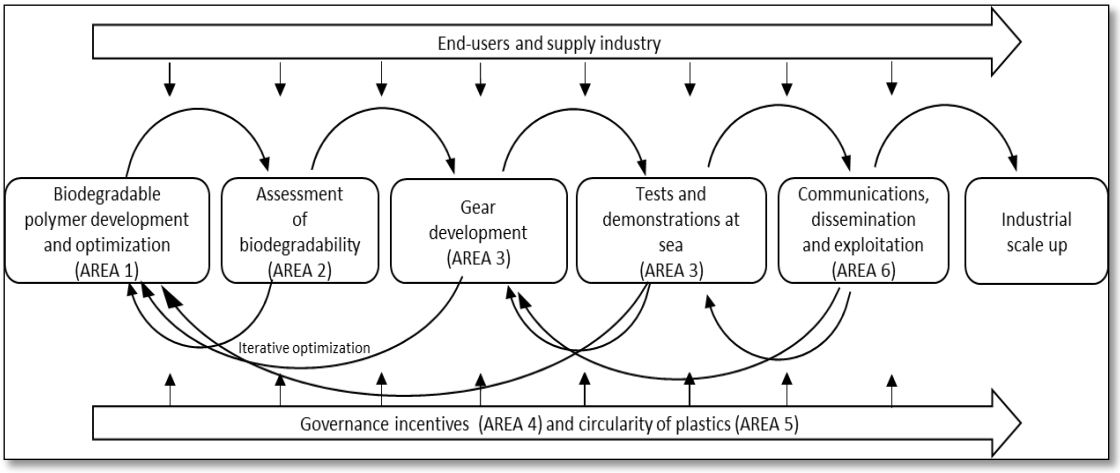


Figure 9.50. Conceptual structure of the SFI Biodegradable plastics. The product-orientated areas represent a value chain perspective, while policy goals connect to the total value chain. The iteration processes for research and development constitute a stepwise approach, from basic research to full-scale testing of prototype applications.

9.15 Portugal

9.15.1 Projects

9.15.1.1 TramSel (G-22-64372)

Project Timeframe: May 2023 – ongoing

Institution(s): CCMAR/IPMA

Contact person: Monika Jadwiga Szynaka, mjszynaka@gmail.com

Link(s): https://ccmar.ualg.pt/en/project/trammel-net-selectivity

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Summary: TramSel aims to reduce the by-catch of habitat forming species caught in specialized gillnets known as trammel nets through a simple modification raising the standard net off the bottom, with guidance from fishers to increase the chance of future adoption

9.15.1.2 Validation of proposed métiers in the multi-gear fleet

Questionnaires were carried out in the ports along the Southern and Western coast of Portugal with fishers working with gillnets and trammel nets. Data from questionnaires/interviews carried out in port with skippers of various fleets (including artisanal and multi-gear coastal fleets) were analysed, with a focus on information on the fishing gear used and the operations, with the aim of validating proposed métiers for this fleet (Szynaka et al. 2021, 2022). Furthermore, the fishers were asked for their opinions on the results of fishing experiments using a modified trammel net (within the framework of the project TecPescas) and if they were able to identify the better-known habitat forming invertebrates, including soft and hard corals and sponges often caught in set nets. Finally, the fishers were invited to participate in a workshop focusing on making improvements to set nets, such as improving the "aranha" from TecPescas and using multi-filament instead of mono-filament.

9.15.1.3 Improvement of the selectivity in gillnets using a modified multi-filament net - "aranha"

Selectivity experiments initiated with a multi-gear coastal vessel operating off the North-Western Portuguese coast were completed between November 2023 and December 2023, testing modified gill nets targeting the European hake (*Merluccius merluccius*) equipped with a net section, known as "aranha" (as seen in Figure 9.51) used to lift the net off the bottom to reduce contact with rocky sediment. The results of the comparative tests demonstrated that this solution contributes to environmental sustainability, reducing the capture of sensitive species such as corals and sponges and the destruction of essential habitats, without significant loss of target species and commercial catch. Regarding the economic competitiveness, the use of the modified net was found to reduce the costs associated with repairing or buying new panels to replace those that are destroyed in this type of sediment. The skipper stated that they would prefer to use the modified nets in the future as they are more durable than the ones they typically use due to the multi-filament material and reduction of contact with the bottom.

Figure 9.51. A simplified version of the modification applied to an 80 mm gillnet used to target hake.

9.15.1.4 Improvement of the selectivity in trammel net using a modified multi-filament net - "aranha"

The selectivity experiments initiated onboard an artisanal vessel operating off the southern Portuguese coast were completed between March 2024 and April 2024, testing trammel nets targeting cuttlefish (*Sepia officinalis*) equipped with a modified net section ("aranha"), forming a diagonal pattern (Figure 9.52). These results are currently being analysed.

Figure 9.52. An updated version of the modification applied to a 120 mm cuttlefish trammel net.

9.15.1.5 Continuation of the project

The project will continue in the coming year 2025. This concept will be applied to different set nets continuously used in various fisheries, keeping a logbook of the nets' performance and examining the net damage over time. Furthermore, video footages will be produced to disseminate results and possible opportunities to apply the modification in other fisheries in various areas on a global scale.

9.16 Scotland

9.16.1 Contact person

- Emma Mackenzie, Marine Scotland, emma.mackenzie@gov.scot

9.16.2 Summary

- CodSELect laboratory tank trials investigating phototactic behaviour of cod and saithe
- CodSELect research survey MRV Alba na Mara
- CodSELect research survey FV Westro PD20
- Off bottom trawling

9.16.3 Projects

9.16.3.1 CodSELect – laboratory tank trials

Project Full Title: CodSELect - Using light to improve cod selectivity in North Sea Nephrops trawl gears

Project Timeframe: November 2022 – March 2024

Institution(s): Marine Directorate (Scottish Government) and Photosynergy Limited at the University of St Andrews

Contact person: Emma Mackenzie, emma.mackenzie@gov.scot

Link(s): FISP projects: grants and contracts awarded in round 2 of the scheme - GOV.UK (www.gov.uk), Data available through MEDIN: https://doi.org/10.7489/12491-1

Is the project directly addressing bycatch of PETS? ~~Yes~~ / No (delete as appropriate)

Could this project indirectly decrease bycatch of PETS? Yes / ~~No~~ (delete as appropriate)

Is the project addressing ALDFG? ~~Yes~~ / No (delete as appropriate)

Summary: CodSELect was a funded project through the Fisheries Industry Science Partnership (FISP) scheme as part of the UK Seafood Fund by DEFRA. CodSELect aimed to support North Sea Nephrops fishers with a new technical measure to reduce the capture of cod and maintain catch of their target species.

CodSELect originated from previously observed behaviour of cod in a laboratory tank trial, completed by Marine Directorate (MD), where cod showed negative phototaxis to blue and green artificial light. CodSELect looked to further investigated this previously observed negative phototactic behaviour in a series of laboratory tank trials to create a comprehensive dataset of phototactic behaviour of cod to a range of artificial light parameters. In total 7 trials were completed, 6 of which observed cod behaviour and a 7th and final trial observing saithe behaviour in response to artificial light. The light parameters tested included 4 different wavelengths; blue 460 nm, green 530 nm, red 650 nm and white 4000K constant light, as well as strobing light in the same wavelengths, either at 1 Hz at 5% or 50% strobing frequency. The light was generated with Photosynergy Ltd LED light pods and a coiled 20 m length of fibre optic cable (Figure 9.53 and Figure 9.54). Light pod specifications can be found in Table 9.3.

The observed behaviours from the laboratory tank trials were highly variable, both within trials with the same fish and between trials with different fish. Across all trials the artificial light either elicited a negative phototactic response (moving away) from the light or no significant response; in no trials was a positive phototactic response (moving towards) found. Further details on results and tank trial design can be provided using the contact details above.

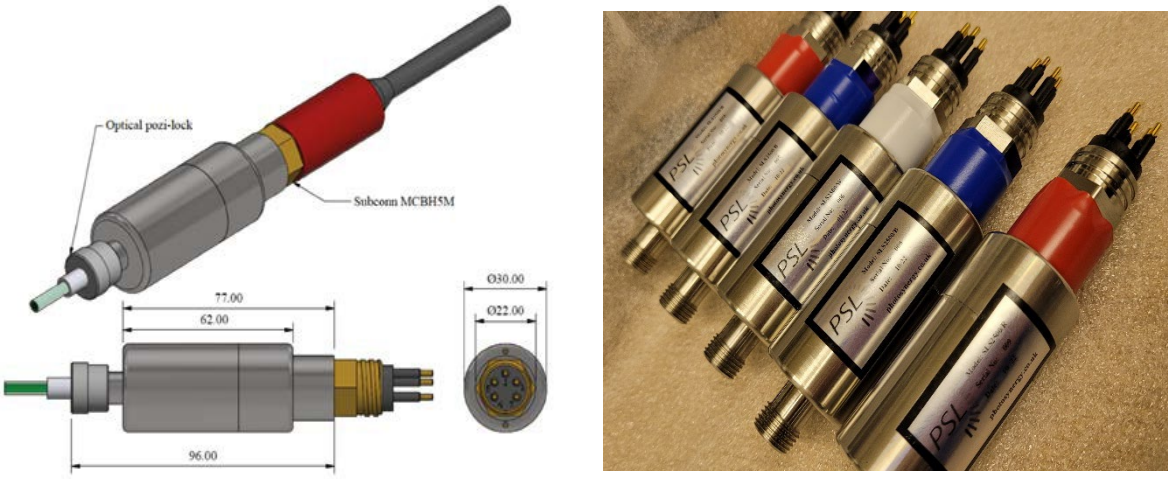


Figure 9.53. SLS2500 Photosynergy single output LED light pods with technical drawing specifications.

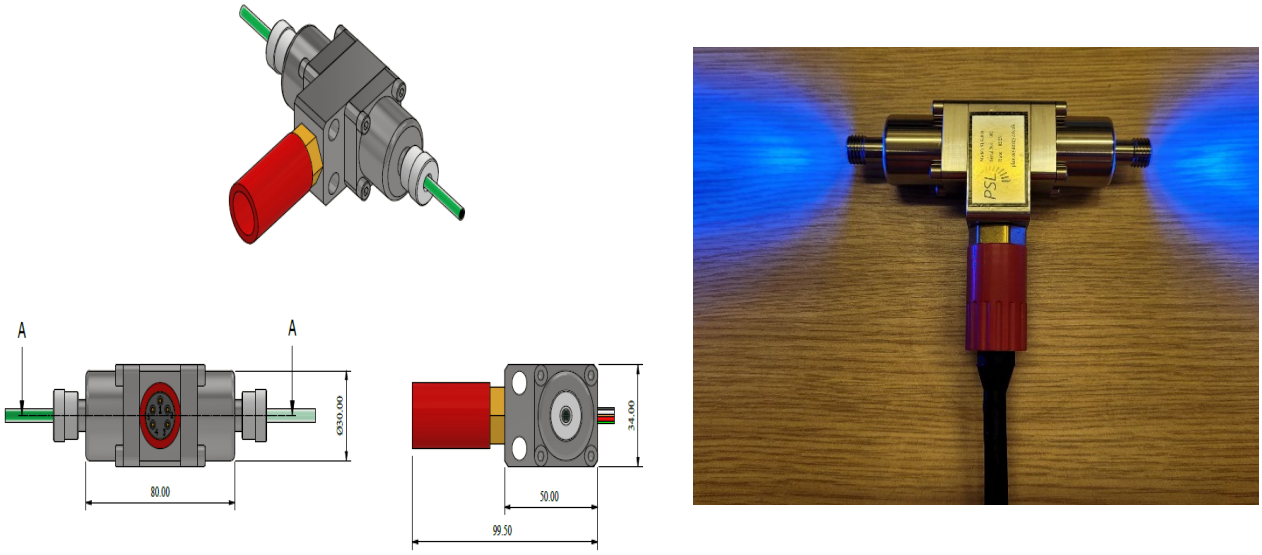


Figure 9.54. SLS4000 Photosynergy dual output LED light pods with technical drawing specifications.

Table 9.3. Specifications for all Photosynergy LED lights pods available for use in the CodSELect project

Light pod	s/n	LED maker	LED model	Colour	Wavelength	LED current	Power draw	Output power	Light Intensity
					(nm)	(A)	(W)	(mW)	µmol m^{-2} s^{-1}
Pre-CodSELect								(Note 1)	(Note 2)
PSL5000	16	Luminus	CBT-40	green	530	1.4	7.0	41	0.60
PSL5000	19	Luminus	CBT-40	green	530	1.4	7.0	35	0.23
SLS2500 Mk 1	1	Luminus	PT-39	green	530	1.5	7.3	55	1.10
SLS2500 Mk 1	2	Luminus	PT-39	green	530	1.5	7.3	56	0.81
SLS2500	5	Osram	Oslon SSL80	white	4000K	1	3.9	106	1.97
SLS2500	6	Osram	Oslon SSL80	white	4000K	1	3.9	106	1.97
CodSELect									
SLS2500 Mk 1	4	Luminus	PT-39	blue	460	1.5	7.3	108	2.64
SLS2500	7	Luminus	PT-39	blue	460	1.5	7.3	130	2.72
SLS2500	8	Luminus	PT-39	blue	460	1.5	7.3	120	2.46
SLS2500	9	Luminus	PT-39	red	650	1.5	5.0	55	1.42
SLS2500	10	Luminus	PT-39	red	650	1.5	5.0	50	1.30
SLS2500	11	Osram	Oslon SSL80	infrared	730	1	3.0	31	N/A
SLS2500	12	Osram	Oslon SSL80	infrared	730	1	3.0	27	N/A
SLS2500	13	Osram	Oslon SSL80	white	4000K	1	4.0	109	2.17
SLS2500	14	Osram	Oslon SSL80	white	4000K	1	4.0	106	2.18
Dual output									(Note 3)
SLS4000	1	Osram	Oslon SSL80	blue	470	1	7.2	110/108	1.71
SLS4000	2	Osram	Oslon SSL80	blue	470	1	7.1	112/105	1.68
SLS4000	3	Osram	Oslon SSL80	green	532	1	6.9	54/56	1.01
SLS4000	4	Osram	Oslon SSL80	green	532	1	6.9	56/57	1.07
SLS4000	5	Osram	Oslon SSL80	white	4000K	1	7.2	80/80	1.44
SLS4000	6	Osram	Oslon SSL80	white	4000K	1	7.1	71/88	1.37
SLS4000 (PET-P)	11	Osram	Oslon SSL80	red	623	1	5.8	110/108	1.86
SLS4000 (PET-P)	12	Osram	Oslon SSL80	red	623	1	6.0	99/101	2.10
Note 1	Output power as measured at the end of 4m test fibre								
Note 2	12 cm above 22 cm diameter of coiled FO 20m length powered by modulation unit 5.000/100%								
Note 3	Dual pod measurments one side was capped with yellow cap								

9.16.3.2 CodSELect Marine Directorate Research Survey – MRV Alba na Mara

Project Full Title: CodSELect - Using light to improve cod selectivity in North Sea Nephrops trawl gears

Project Timeframe: 18th May – 30th May 2023

Institution(s): Marine Directorate (Scottish Government) and Photosynergy Limited at the University of St Andrews

Contact person: Emma Mackenzie, emma.mackenzie@gov.scot or Alex Edridge, Alexius.edridge@gov.scot

Link(s): FISP projects: grants and contracts awarded in round 2 of the scheme - GOV.UK (www.gov.uk), Data available through MEDIN: https://doi.org/10.7489/12493-1

Is the project directly addressing bycatch of PETS? ~~Yes~~ / No (delete as appropriate)

Could this project indirectly decrease bycatch of PETS? Yes / ~~No~~ (delete as appropriate)

Is the project addressing ALDFG? ~~Yes~~ / No (delete as appropriate)

Summary: CodSELect was a funded project through the Fisheries Industry Science Partnership (FISP) scheme as part of the UK Seafood Fund by DEFRA. CodSELect aimed to support North

Sea Nephrops fishers with a new technical measure to reduce the capture of cod and maintain catch of their target species.

Objective:

Investigate whether blue 460 nm artificial light can influence fish behaviour and enhance escape through a 300 mm square mesh panel (SMP) in the extension of the trawl inserted in the top panel of a SELTRA box rigged in the extension of a Nephrops trawl.

The trials used a Nephrops scraper trawl (designated BT201) fitted with a four panel extension section known as a SELTRA sorting box. The SELTRA incorporated a 300 mm SMP on the top panel, situated 8.7 m from the codline. The codend was made out of green low tenacity twine. The bottom panel of the SELTRA was rigged with a panel insert positioned 30 cm ahead of the SMP and fitted with a 20 metre length of fibre optic (FO) cable. The FO cable was illuminated by two 460 nm (blue) Photosynergy SLS2500 LED light pod units at each end to produce a uniform intensity output along the length of the fibre optic cable. The SLS2500 were initially powered by the 12 Volt battery packs made in house by the Marine Directorates' engineering unit based in the Marine Laboratory in Aberdeen and subsequently powered by newly developed battery packs, Photosynergy SBS500 batteries, designed as part of the research and development objectives of the project. The FO cable was fitted along the length of an insert in the bottom panel of the SELTRA as illustrated in Figure 9.55. In total 30 valid hauls were carried out in the broader area between Southeast of the Fetlar island and West of Pobie Bank (ICES Stat.Rect.50E9) and South of Sumburgh Head (ICES Stat.Rect.48E8) at depths of approximately 80 – 150 metres. Hauls were conducted in pairs with one haul being the control (without lights) and the other the test (with light on), providing 15 pair hauls for analysis. Turbidity and downwelling PAR data was also collected to provide an insight into the environmental conditions at the time of fishing. No significant differences in relative catch rates or length effects were found from the species catch data analysed.

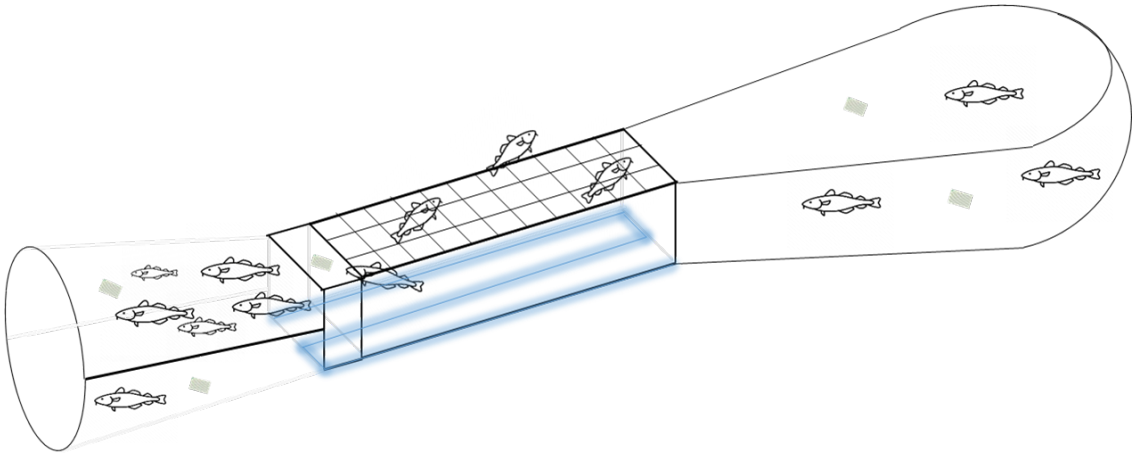


Figure 9.55. SELTRA box with 300 mm SMP and the net-mounting configuration of illuminated bottom panel. The configuration utilises a 20 m Lightpath fibre optic cable injected in each end by SLS2500 LED light pods to produce uniform intensity output throughout the length of the fibre. The units used in the trials emitted a wavelength of 460 nm (blue).

9.16.3.3 CodSELect Marine Directorate Commercial Fishing Trial – FV Westro PD20

Project Full Title: CodSELect - Using light to improve cod selectivity in North Sea Nephrops trawl gears

Project Timeframe: 3rd – 9th October 2023

Institution(s): Marine Directorate (Scottish Government), Marine Environmental Solutions Limited owned by The Scottish Fishermen's Federation (SFF) and Photosynergy Limited at the University of St Andrews

Contact person: Emma Mackenzie, emma.mackenzie@gov.scot or Alex Edridge, Alexius.edridge@gov.scot

Link(s):): FISP projects: grants and contracts awarded in round 2 of the scheme - GOV.UK (www.gov.uk), Data available through MEDIN: https://doi.org/10.7489/12494-1

Is the project directly addressing bycatch of PETS? ~~Yes~~ / No (delete as appropriate)

Could this project indirectly decrease bycatch of PETS? Yes / ~~No~~ (delete as appropriate)

Is the project addressing ALDFG? ~~Yes~~ / No (delete as appropriate)

Summary: CodSELect was a funded project through the Fisheries Industry Science Partnership (FISP) scheme as part of the UK Seafood Fund by DEFRA. CodSELect aimed to support North Sea Nephrops fishers with a new technical measure to reduce the capture of cod and maintain catch of their target species.

Objective:

Investigate whether white 4000K artificial light can influence fish behaviour and enhance escape through a 300 mm square mesh panel (SMP) in the extension of the trawl inserted in the top panel of a SELTRA box rigged in the extension of a Nephrops trawl

The trials used a twin trawl set-up on the Westro PD20 fishing vessel using their own Nephrops trawl with a 230 mm SMP (control net) alongside a modified trawl (test trawl. The test trawl consisted of a tapered section with a fishing circle of 200 diamond meshes x 80 mm provided by the fishing vessel with the 230 mm SMP removed and fitted with a four panel extension section known as a SELTRA sorting box. The SELTRA incorporated a 300 mm SMP on the top panel, situated 9 m from the codline. Both control and test trawls were fitted with new 80 mm codends, prepared by Scotnet trawl net manufacturers, and supplied by the Marine Directorate. The bottom panel of the SELTRA was rigged with a panel insert positioned 30 cm ahead of the SMP and fitted with a 20 metre length of fibre optic (FO) cable. The FO cable was illuminated by two white 4000K Photosynergy SLS2500 LED light pod units at each end to produce a uniform intensity output along the length of the fibre optic cable. The SLS2500 were initially powered Photosynergy SBS500 battery packs, designed as part of the research and development objectives of the project. The FO cable was fitted along the length of an insert in the bottom panel of the SELTRA as illustrated in Figure 9.56.

A total 18 hauls were completed, 17 of which were valid and used for the catch comparison analysis. Due to time constraints, haul duration was limited to 2 hours and fishing ground location was fixed to the N.Piper grounds (Stat.Sq. 44F0; Fig. 41), an area selected by the vessel's skipper for its mix of both Nephrops and whitefish. For the first half of the trip the test gear was deployed on the port side, during daylight hours, switching sides mid-trip to reduce possible side bias. Turbidity and downwelling PAR data was also collected to provide an insight into the environmental conditions at the time of fishing.

Side was confounded with time with the test gear being the first to be fished on the port side and then on the starboard side, so any 'side' effects could equally be due to some other change in conditions that occurred when the nets were switched over that was not captured otherwise.

Catch weight and length distribution data were collected from 17 species. In summary, only eight species had sufficient data allow a full analysis, only three (cod, long rough dab and monkfish) had relative catch rates that did not depend on side and where the results can therefore be interpreted with some confidence:

For cod there was weak evidence of a negative length effect on the relative catch rate ($p = 0.048$) with the light reducing the catch of fish greater than 27 cm (pointwise 5% level).

For long rough dab there was no length effect ($p = 0.29$) with light increasing the catch of fish of all lengths ($p < 0.0001$).

For monkfish there was no length effect ($p = 0.75$) and light had no effect on catches ($p = 0.62$).

The remaining five species with sufficient data to fit all models (haddock, Nephrops, saithe, whiting, witch) showed evidence of a side effect and consequently it is difficult to interpret the results.

For haddock and whiting on the port side light increased the catch of small fish and decreased the catch of large fish, whereas on the starboard side light decreased the catch of small fish and increased the catch of large fish.

For Nephrops on the port side light decreased the catch of small individuals and increased the catch of large ones, whereas on the starboard side light had no effect on catch.

For saithe on the port side light increased the catch of all sizes of fish, whereas on the starboard side light had no effect on catch.

For witch on the port side light decreased the catch of all sizes of fish, whereas on the starboard side light had no effect on catch

There was no evidence of any light effect on the catches of hake, lemon sole and ling, although there were limited data for these species.

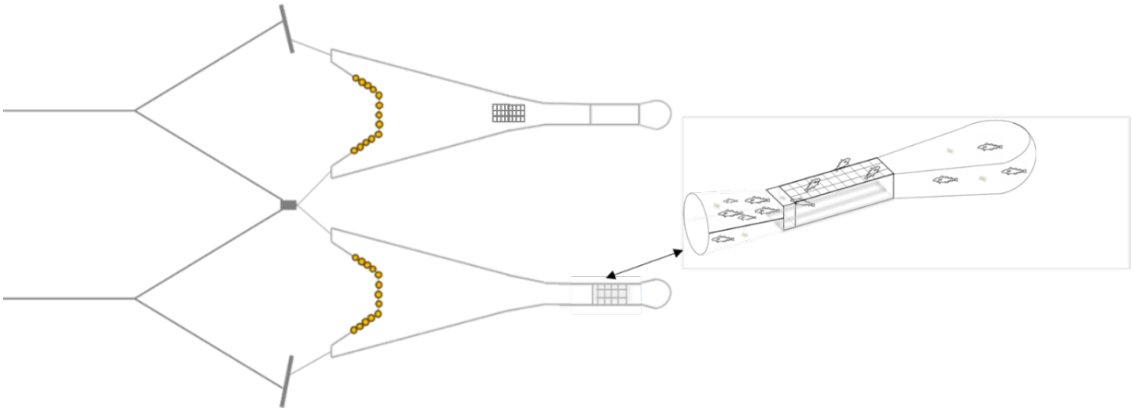


Figure 9.56. Twin trawl illustrating SELTRA box with SMP on the test gear (port side) and the vessel's standard gear as control gear (starboard side). The position of the gears was swapped mid-trip to eliminate any possible side effect bias. Insert illustrates the SELTRA box with 300 mm SMP and illuminated bottom panel. The LED units used in the trials emitted white light (4000 K). Diagram not to scale.

9.16.3.4 Project: Development off-bottom trawling system for inshore Nephrops fleet

Project Full Title: To undertake sea trials in developing an off-bottom (trawl door and sweep) system for the Scottish inshore Nephrops fleet.

Project Timeframe: September 2023 – March 2024

Institution(s): Marine Scotland and IBTSWG

Contact person: Robert Kynoch, Robert.Kynoch@scot.gov

Link(s): N/A

Is the project directly addressing bycatch of PETS? No (delete as appropriate)

Could this project indirectly decrease bycatch of PETS? No (delete as appropriate)

Is the project addressing ALDFG? No (delete as appropriate)

Summary:

Objectives

As many typical Scottish inshore fishing grounds are being designated as Marine Protected Areas there is potential for Scottish inshore nephrops vessels to assess the potential of semi-pelagic gears. Another benefit is to reduce unwanted fish by-catches as many of these smaller vessels have limited or no fish quotas.

The first cruise was undertaken on the Marine Directorate research vessel Alba-na-Mara during September 2023. The main objective was to assess the performance in terms of stability of a Nephrops trawl rigged to fish with semi-pelagic trawl doors (Thyboron Type 15 vf - 370kg x 2.5m^2) and sweeps fully off-bottom with only dropper chains suspended from the fishingline (spaced at 0.5m intervals) in contact with the seabed. It was found the trawl doors orientated approximately 1-2m above the seabed and were very stable. However, with the sweeps fishing off the seabed the trawl would only maintain station above the seabed for around 10-15 minutes due to tidal effects and vessel speed changes.

Due to the poor trawl stability found during the September (2023) cruise a further gear development and catch comparison cruise was undertake on Alba-na-Mara during March 2024. Using the lessons learned from the previous cruise the objective was to fish the same trawl doors and sweeps off-bottom but keep the trawl on the seabed using a light hopper ground gear rig. The wire sweeps for the off-bottom fishing were replaced by Dyneema rope. Prior to the cruise new skid keels were fitted to the Thyboron trawl doors to enable them to fish the demersal rig. Once the off-bottom rig was configured correctly the intention was to undertake catch comparison hauls comparing the tradition (on-bottom) rig against the new off-bottom Dyneema rig. However, the Dyneema rig was found to have in-sufficient drag and the trawl doors tended to over spread and lift which compromised ground gear catchability for Nephrops. The Dyneema rig was abandoned and the wire rig was used for the remainder of the cruise. The trawl doors again fished approximately 1-2m off the seabed but it was felt the doors were too big (surface area 2.5m^2) for this setup. Although the single sweeps fished off-bottom the lower bridles were on the seabed and provided a herding effect.

There are no plans to continue this work for at least 12 months but for future trials similar semi-pelagic trawl doors with a surface area of 2.0m^2 will be used. Combination wire sweeps will replace the wire/Dyneema sweep rigs to ensure there is no sand cloud or heading effect.

9.17 Spain (AZTI)

9.17.1 Contact person

Mikel Basterretxea, AZTI, mbasterretxea@azti.es

9.17.2 Summary

The fishing technology area from AZTI-BRTA has been working last year on studies about selectivity improvements mainly on bottom trawl fleets operating in ICES subarea 8, but also in

the tropical tuna purse seine fishery. All the projects include surveys at sea, performing and evaluating modifications of the fishing gears (geometry modification of the codend, performance of bycatch release devices, or testing the effectiveness of acoustic active deterrent devices).

9.17.3 Projects

9.17.3.1 Project: Lastridge ropes and T90 Codend to improve selectivity in bottom trawl in BoB

Project Full Title: Improvement of selectivity in trawl fisheries under the Landing Obligation of the C.F.P

Project Timeframe: January 2024 – December 2024

Institution(s): AZTI

Contact person: Mikel Basterretxea, mbasterretxea@azti.es

Link(s): www.azti.es

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: CASELEM was a one-year project, funded by Spanish Fishing Directorate. The aim of this project was to analyse the potential technical and operational solutions to reduce the capture of non-desired species in the Landing Obligation framework. The project aims at analysing the potential of shortening lastridge ropes in the first ¾ of the codend and a T90 codend to improve size selectivity of commercially relevant species in the Basque bottom trawl fishery operating in ICES 8abd. Sea trials were carried out onboard R/V Emma Bardan and selectivity data for hake, horse mackerel, blue whiting, boarfish and megrim was collected. Results indicated that megrim was significantly less retained by the 15% shortened lastridge codend compared to the non-shortened one. With the T90 configuration, most species showed higher scape rate.

Additionally, underwater recordings showed clear visual differences regarding mesh openness between codends with shortened lastridge ropes and the baseline. The project will continue in 2024, with new experiment configurations with the aimed at further improving selectivity.

9.17.3.2 Assessing the impact of fishing on marine habitats and species in BoB

Project Full Title: Obtaining data on the impact of fishing on benthic habitats

Project Timeframe: January 2024 – December 2024

Institution(s): AZTI

Contact person: Ibon Galparsoro, igalparsoro@azti.es

Link(s): www.azti.es

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The effects on ecosystems of fishing gear with contact with the bottom are highly relevant for management. The severity of the impact depends on the type of fishing gear; as well as the seabed characteristics, the biological communities living on or on the seabed, and the intensity and frequency of fishing activity. Therefore, to make a good approximation of the

environmental impacts of fishing, it is necessary to have, on the one hand, data related to the spatial and temporal distribution of fishing activity by each modality (*metier*) and, on the other hand, information related to both the physical and morphological characteristics of the seabed, as well as the biological communities present (i.e., information on benthic habitats where fishing is carried out). As part of the European Union's multiannual programme for the collection and management of the data necessary to assess the impact of fishing on marine habitats and species recorded under Regulation (EC) No 1224/2009, AZTI is conducting a monitoring programme in the continental shelf of the Basque Country (SE Bay of Biscay).

The main objective of the project is the fine-tuning of sampling techniques, as well as the acquisition of data that allow the assessment of the environmental status to derive the potential impacts of fishing activity on benthic habitats. For that, appropriate sampling methods have been applied, including methods determined by specific studies (CE2021/1167; L253/56). Sediment and fauna sampling are carried out onboard of the B/O Emma Bardán, of the General Secretariat of Fisheries (SGP).

Surface sediment samples and infaunal organisms (macrobenthos) are obtained with grabs. In addition, epifaunal sampling is carried out with a beam trawl. A video survey was carried out, using a remotely operated vehicle (ROV). The videos and images obtained are representative of different types of benthic habitats and areas under different levels of intensity and fishing gears.

The preliminary results indicate that the obtained data, generate valuable information for the subsequent analysis of the effects, on benthic communities, of fishing gears in contact with the bottom. Future work includes the detailed analysis of the results obtained in the 2022 and 2023 campaigns, which includes a detailed classification of biological traits of sampled species and statistical analysis of data.

9.17.3.3 Testing of the effectiveness of pingers in mitigating the incidental bycatch of dolphins in pair bottom trawling in BoB

Project Full Title: Exhaustive testing of the effectiveness of acoustic active deterrent devices (pingers) in mitigating the incidental bycatch of dolphins in pair bottom trawling.

Project Timeframe: January 2021 – December 2024

Institution(s): AZTI

Contact person: Elsa Cuende, ecuende@azti.es

Link(s): www.azti.es

Summary: MITICET is a four-year project, started in January 2021 and it is funded by the Spanish Fisheries Directorate. The testing of acoustic active deterrent devices (pingers) for dolphins started in March 2021, with the main objective of comparing the incidental bycatch of dolphins by implementing an alternate hauls experimental design (with and without pingers) of the pair trawl unit. In order to record the incidental by-catches, both vessels were equipped with Electronic Monitoring Systems (EMS), which allowed to visualize any cetacean bycatch onboard in all the fishing hauls. This equipment was operational during several months, covering all the period in which the major cetacean bycatch was expected in the fishing area. Given the known relatively low frequency of the cetacean bycatch events, one of the challenges was to obtain a number of observations high enough to perform a robust statistical analysis so that the pingers effectiveness can be estimated. The pinger model was less powerful than the one used in 2022, but with the capacity to endure all the year without recharging the battery.

Results in 2023 showed no reduction in the proportion of hauls with bycatch of common dolphin but the number of specimens per haul with bycatch was significantly reduced.

In 2024 the project continues, with the same approach of the previous year but with a different model of pinger.

9.18 Sweden

9.18.1 Contact person

- Mikael Ovegård, Swedish University of Agricultural Sciences, mikael.ovegard@slu.se
- Peter Ljungberg, Swedish University of Agricultural Sciences, peter.ljungberg@slu.se

9.18.2 Summary

- Secretariat for selective fishing gear
- Round goby – from Risk to Resource
- Wind4COCO
- Promoting commercial fishing of round goby in the Baltic Sea

9.18.3 Projects

9.18.3.1 Project: Secretariat for selective fishing gear

Project Full Title: Secretariat for selective fishing gear

Project Timeframe: 2014 – 2024

Institution(s): Swedish University of Agricultural Sciences, Aquatic resources

Contact person: Mikael Ovegård, mikael.ovegard@slu.se

Link(s): https://www.slu.se/institutioner/akvatiska-resurser/forskning/hallbart-fiske/selektivt-och-skonsamt-fiske/sektretariatet/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Swedish government has set aside special funding for collaborative research on selective fishing gears. The main background was the need for a larger toolbox of documented and workable gears for the industry to choose from when the landing obligation in EU fisheries is being implemented. In this venture, SLU-Aqua has been contracted by the responsible authority (SwAM - Swedish Agency for Marine and Water Management) to set up a secretariat.

The aim of the secretariat has been to gather new ideas from fishers and industry. The industry´s initiative and engagement are crucial to the successful development of new ideas. Project proposals are worked out in close collaboration between fishers and scientists and are then evaluated and funded by SwAM.

During the project period between 2014 and 2023, over 50 projects have been completed with a great diversity ranging from the gentle handling of salmon in traps in the northern Baltic Sea to large grids excluding saithe in the industrial pelagic trawl-fishery of herring in the Skagerrak and experiment with pelagic trawl doors in the demersal trawl fishery.

9.18.3.2 Project: Round goby – from Risk to Resource

Project Full Title: Round goby – from Risk to Resource

Project Timeframe: Jan 2021 – Mar 2025

Institution(s): Swedish University of Agricultural Sciences, Aquatic resources, Lund University, Umeå University

Contact person: Peter Ljungberg, peter.ljungberg@slu.se, Ann-Britt Florin, ann-britt.florin@slu.se

Link(s): https://www.slu.se/institutioner/akvatiska-resurser/forskning1/ekosystem/svartmunnad-smorbult--forvandla-risk-till-resurs/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: With start in 2021 nationally founded project containing aspects of catchability of the invasive round goby (Neogobius melanostomus) is part of a larger, four year project in Sweden. The fishery related part includes aims to evaluate how commercial fishing of round goby may be included in the coastal fishery. Two key issues are how round goby may be retained in the gear while European eel (Anguilla anguilla) may be released through selection panels. Also, the selection panels have to be evaluated also for their retention potential for other commercial species.

9.18.3.3 Wind4COCO

Project Full Title: Wind4coco

Project Timeframe: Mar 2024 –Dec 2026

Institution(s): Swedish University of Agricultural Sciences, Aquatic resources.

Contact person: Peter Ljungberg, peter.ljungberg@slu.se., Lena Bergström, lena.bergstrom@slu.se

Link(s): No

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The WIND4COCO project aims to facilitate the precautionary expansion of marine renewables by knowledge development on the long-term and cumulative effects of offshore wind farms (OWF) on fish and biodiversity, and on the possibilities for OWF to co-exist with conservation and fisheries. We will conduct field studies at the Lillgrund OWF in southern Sweden, which was established in 2007. At that time, the Lillgrund OWF had among the most comprehensive OWF monitoring programs globally. We will revisit parts of this program to study how the fish communities and the reef effects that were observed during the first years of operation have developed further over time. Further, we will expand the previous studies with new methods targeting effects on biodiversity and possible coexistence with fisheries. We will use baited remote underwater video to obtain a more refined view of biodiversity patterns in the OWF and compare this with other areas comprised of different levels of habitat complexity and protection status. Further, we will test a recently developed selective fishing gear, baited fish pots, in the OWF setting and evaluate the potential for using these as well as creels (targeting Norway lobster) in OWFs generally. We will evaluate our results in workshops with key stakeholders, to explore possible sustainable solutions for new OWFs as well as to develop recommendations for a coherent OWF monitoring and data sharing that can support further

incremental knowledge development as more OWFs are installed. Hence, our results can inform both the sustainable design of OWFs and the development of methods to monitor local and cumulative OWF effects, supporting a sustainable renewable energy development.

9.18.3.4 Promoting commercial fishery of round goby in the Baltic Sea

Project Full Title: Promoting commercial fishing of round goby in the Baltic Sea

Project Timeframe: Jan 2024 – Dec 2026

Institution(s): Swedish University of Agricultural Sciences, Aquatic resources, Marine Center in Simrishamn

Contact person: Peter Ljungberg, peter.ljungberg@slu.se

Link(s): https://interreg-baltic.eu/project/roundgoby/

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Baltic Sea fishery currently experiences severe limits of total allowable catches for traditional fish species (cod, herring). At same time, the Round Goby (RG), an invasive fish species to the Baltic Sea, is not subject to these limits. It is by now the predominant fish species in many Baltic coastal areas and is continuously increasing its range and abundance. This has negative effects on epibenthic mollusks and native fish roe; but national initiatives to address this potentially new resource, and hence mitigate its negative impacts, have so far been scarce. Moreover, fishery opportunities are so far limited as with current fishing gear by-catch of native smaller species is a risk. Also, whereas RG is commonly used for human consumption in the Black Sea region, it is neither known to Baltic consumers nor are fish processing lines adapted to its small size. Latvia is currently the only BSR country that has commercial RG fishing for export and a RG management scheme. Through transnational cooperation and competence-building of fishers, gear manufacturers, the industry and relevant regulatory authorities, the Round Goby project will promote RG fishing by exploring management options, develop jointly approved fishing methods and report systems as well as showcase production of high value products for local markets. The project will open new opportunities for Baltic fishermen while reducing the population of an invasive species which threatens the Baltic Sea's biodiversity.

9.19 The Netherlands

9.19.1 Contact person

- Pieke Molenaar, Wageningen Marine Research, pieke.molenaar@wur.nl

9.19.2 Summary

- The low Impact Bottom Trawling project developed a fish detection system based on electrical properties of fish water and sediment, the system is capable of detecting buried flatfish.
- SimTech aims to develop new catching techniques for flatfish that substantially reduce the impact compared to current beam trawl methods.
- Within Cibbrina 13 European countries work jointly to minimize incidental bycatch in fisheries which have a high risk of bycatch of priority marine ETP species

- FDF aim to develop an autonomous video-based monitoring system for recording catches, achieving automated catch registration without interference from fishers (log-books) or on-board observers.
- Gill netting in windfarms assesses the feasibility of gillnet fishing in a wind farm (technically, economically, ecologically and in terms of safety)
- Selectivity and Survival aimed to develop and test gear innovations aimed at reducing fisheries mortality among undersized fish by either avoid that they are caught (increased selectivity) or increasing their survival probability when discarded.
- MASENRO 2.0 aims to develop methods for automatic species recognition, individual counts and length detection of (flat)fish on the seabed and inside flyshoot trawls.
- Passive shrimp fisheries aims to investigates with field trials weather two passive methods could be an technical and economical alternative for shrimp beam trawling in the Waddensea
- MHS2.0 aims to further develop the application of the Modular Harvest System in demersal fisheries in the North Sea.
- A proposed squid research project will aim to develop stock assessment models for North Sea squid and explores technological solutions for undersized fish bycatch in the current squid trawl and flyshoot fisheries.

9.19.3 Projects

9.19.3.1 Project: Low Impact Bottom Trawling

Project Full Title: Low Impact Bottom Trawling

Project Timeframe: July 2021 – July 2024

Institution(s): Wageningen University

Contact persons: Martin Lankheet, Wageningen University, martin.lankheet@wur.nl

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Detection and counting of fish is of crucial importance for sustainable water resources management, fisheries, and aquaculture. Various types of water reservoirs and environments pose specific challenges in this regard, which need to be addressed using specific technological means. While echosounders and sonar systems perform very well in open waters, and cameras prove useful under certain conditions with good visibility, there are still important cases for which we do not have adequate solutions. An example application in which a new fish detection technology could be a major gamechanger is flatfish detection on (within) the seafloor. Current bottom trawling techniques are non-selective and harmful to the environment, as they rely on dragging heavy objects on the seafloor to startle the fish into the net. Flatfish are extremely hard to detect by echosounders, as they do not have swim bladders. They are also practically invisible to the cameras, as they cover themselves with sediments and use a natural camouflage for protection. A relevant remote flatfish detection system would enable construction of a new generation of bottom trawling techniques with minimized ecological impact. In such techniques a startling stimuli would be triggered only if a fish would be detected. Currently, there are no technological means which would allow that.

Within the framework of the project, we have developed a novel fish detection system capable of detecting flatfish, even if buried in the seafloor. The principle of its operation is based on continuous monitoring of electrical properties of environment, taking advantage of the fact that

electrical characteristics of fish tissues differ from the ones of ambient water and bottom sediments. The system utilizes a set of electrodes in a form of metal patches, attached to a non-insulating carrier beam which is dragged above the seafloor. Detection signals are of very low voltage amplitudes and current intensity (typically below 1 V and several mA), which make them completely harmless to the environment and imperceptible to marine wildlife. It is fully scalable, as it might contain any number of independent measurement channels connected in a form of an electrode matrix. In this way it is possible to extend detection region or to obtain additional information on the detected fish. The electrodes are connected to an electronic sensing system, which processes the signals and performs detection. It can be used, e.g., to trigger startling stimuli in the envisioned new generation of low-impact bottom trawling gear. Other possible applications include marine wildlife monitoring system for research purposes.

We have tested the described approach both in the laboratory and in the simulated marine environment, under near real-world conditions. In the latter case we used a large, 30 m long experimental tank filled with sea water, with a thick sand layer on the bottom. All the experiments demonstrated high detection efficiency of the system. Our studies allowed us to develop both deep understanding of the mechanisms and phenomena underlying electrical impedance-based fish detection, and a number of experimental and numerical tools for design, testing, and optimization of the system's components. Together, they constitute an unique set of resources and experiences required for further steps towards practical implementation of the new fish detection approach.

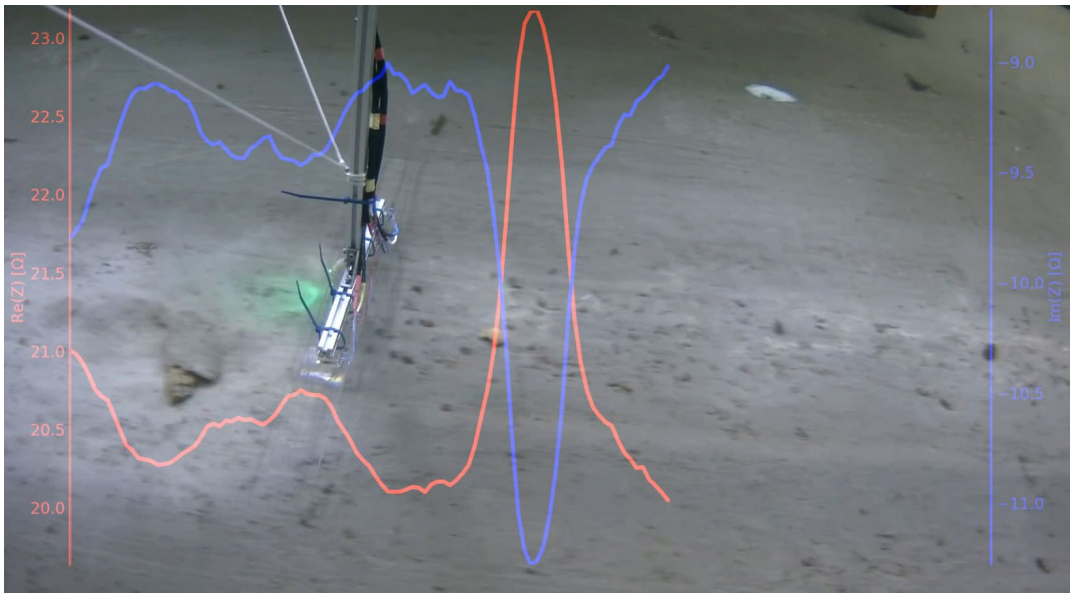


Figure 9.57. Detection of flatfish by electrical property changes while towing the experimental setup over a buried flatfish.

9.19.3.2 Project: New stimulation techniques for flatfish trawling (StimTech)

Project Full Title: New stimulation techniques for flatfish trawling

Project Timeframe: September 2022 – September 2027

Institution(s): Wageningen University and Research (WUR), Delft University of Technology (TUD), Wageningen Marine Research (WMR)

Contact person: Johan van Leeuwen, Wageningen University, johan.vanleeuwen@wur.nl

Link(s): https://www.nwo.nl/onderzoeksprogrammas/onderzoek-voor-duurzame-visserij

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This project aims to develop new catching techniques for sole and plaice that substantially reduce the disadvantages of the tickler chain gear in terms of catching efficiency, without employing electrical fields for capture. The project comprises two lines of research, focusing on fish behaviour (Wageningen University and Research) and the physical impact of new stimuli (Delft University of Technology). At the end of the project, the information will be combined to design and build an integrated field setup.

Flatfish occupy sandy bottom habitats and therefore generally display a lie-and-wait, burying behaviour with short bouts of free swimming. We aim to determine the maximum swimming endurance and performance of commercially targeted sole and plaice. To do this, we encourage swimming and limit settlement behaviour of the fish by use of a modified Loligo® swim tunnel. The experiment utilizes wild caught individuals within a juvenile age class. Quantifying the endurance capacity of the flatfish would provide greater insight into optimising minimum required trawling speeds of beam trawling vessels. We developed a protocol to monitor swimming endurance and will execute an extensive series of measurement in the near future.

Flatfish generally display one of three startle behaviours in response to a threatening stimulus, these being a freeze, withdrawal (burrowing) or escape response. We aim to quantify the burrowing capacity of the flatfish across a range of size classes. Small-scale pilot studies conducted at Wageningen University & Research have indicated sole and plaice to burrow to relatively shallow depths in course sediment. Large-scale escape response and burrowing experiments conducted at Visserij-innovatiecentrum (Stellendam) indicated that once mildly stimulated through lifting the caudal fin, flatfish preferred a burial escape behaviour rather than a fast-start response. In general, the flatfish would perform numerous burial actions before switching to a swimming mode to evade the induced stimuli. Swimming behaviour was observed to occur over short distances and at low speeds between successive borrowing actions. Seldomly, long distance cruising swimming behaviours occurring at low speeds were observed.

Currently, the team at TUD are investigating the physical impact of new stimuli which will focus on the impact of hydraulic stimuli, more specifically water jets. Water jets have the benefits of being controllable and having the potential to trawl a significantly smaller area, as the system can be turned on and off. In addition, knowledge on the velocity and pressure field near the bed required to initiate an escape response in flatfish can potentially be used to develop rigid structures, reducing the fuel needs of the system. The velocity field and erosion depth of water jets will be studied utilizing advanced measurement techniques, such as particle image velocimetry (PIV). In addition, a computational fluid dynamics model will be developed to study the fluid and erosion dynamics in higher detail. In combination with the knowledge on fish behaviour, the parameters of the water jets can be optimized to minimize the bed disturbance.

9.19.3.3 Project: Cibbrina

Project Full Title: Coordinated Development and Implementation of Best Practice in Bycatch Reduction in the North Atlantic, Baltic and Mediterranean Regions

Project Timeframe: 1stof September 2023 – 31-8-2029

Institution(s):

Contact person: for Wageningen Marine Research Edward Schram Edward.schram@wur.nl

Link(s): LIFE 3.0 - LIFE22-NAT-NL-LIFE-CIBBRiNA/101114301 (europa.eu)

Is the project directly addressing bycatch of PETS? YES

Could this project indirectly decrease bycatch of PETS? YES

Is the project addressing ALDFG? NO

Summary: Incidental bycatch has been identified as one of the major threats to marine species worldwide, notably for Endangered, Threatened and Protected (ETP) species. It is the single most important known cause of mortality facing marine ETP species. The number of individuals of ETP species incidentally bycaught annually in European seas is high.

Although this has been recognised for decades, efforts to minimise the bycatch of ETP species of marine mammals, birds, turtles and elasmobranchs have had limited success. One of the main reasons has been the insufficient involvement and buy-in from the fishing industry, exacerbated by a lack of clarity about conservation goals, the fact that some key legislation covers only certain fleets, a limited implementation of legislation and weak enforcement. Both monitoring and mitigation measures have been imposed on large groups of end-users, namely fishers, without consultation and the measures often turn out to be unworkable in practice or to have severe adverse socio-economic consequences.

There are essentially two types of barriers to the reduction of mortality due to incidental bycatch, one technical and the other has to do with implementation. The active involvement of fishers, integration of fisher knowledge and the engagement of gear technologists will help CIBBRiNA to solve technical problems. CIBBRiNA aims to overcome the latter barrier through integration of all levels of the fishing industry along with other stakeholders including national authorities into all stages of the project.

In recent years, there have been several developments demonstrating a need from an international perspective for coordinated efforts to tackle this problem. The LIFE CIBBRiNA project sets out to address this issue by establishing a European flagship initiative in which fishers, scientists, environment ministries and non-governmental organizations (NGOs) from 13 European countries work jointly to minimize incidental bycatch in fisheries which have a high risk of bycatch of priority marine ETP species and to work towards transparent and environmentally and socio-economically sustainable fisheries in the Northeast Atlantic, Baltic and Mediterranean regions.

The main objective of LIFE CIBBRiNA is to minimise and, where possible, eliminate bycatch mortality of priority ETP species. This will be achieved through EU cross-border and cross-sectoral cooperation, involving industry, scientists, authorities and other relevant stakeholders, to establish regionally coordinated mitigation, monitoring and assessment programmes.

The specific objectives are:

- To establish regional monitoring programmes to achieve a steep change in the reliability of bycatch estimates.
- To develop methods to assess the conservation implications of incidental bycatch in data-rich and data-poor situations.
- To create a 'safe environment' to share information and develop viable solutions for all stakeholders involved.
- To develop, demonstrate, promote and stimulate innovative, effective techniques, methods and approaches to reduce the mortality of marine ETP species, including through bycatch.
- To optimise, develop and evaluate mitigation methods and recommend the most appropriate tools while working to ensure their long-term implementation.
- To support effective mitigation by implementing successful monitoring programmes in cooperation with the Regional Coordination Groups (RCGs).

- To gain support from all stakeholders by assessing and successfully addressing the socio-economic implications of proposed measures.
- To achieve successful cross-border cooperation, for implementation of recommended measures, among governmental organisations, the fisheries sector including RCGs, NGOs and scientists.
- To secure long-term funding for the continuation and long-term sustainability of recommended incidental bycatch mitigation measures.

9.19.3.4 Project: Fully Documented Fisheries (FDF) 2.0

Project Full Title: Fully Documented Fisheries 2.0

Project Timeframe: May 2019 – Dec 2023

Institution(s): Wageningen Marine Research, Wageningen Plant Research, Wageningen Research

Contact person: Edwin van Helmond, edwin.vanhelmond@wur.nl

Link(s): https://www.wur.nl/en/project/fully-documented-fisheries-fdf-r0b07a-1.htm

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The aim of the Fully Documented Fisheries (FDF) project is to develop an autonomous video-based monitoring system for recording catches, achieving automated catch registration without interference from fishers (logbooks) or on-board observers. This project marks the second iteration, building upon the foundations of FDF 1.0. A camera and AI image recognition system have been designed, tested, and are currently being installed on board four beam trawlers, one flyshooter, and one otter trawler. Observer trips, in conjunction with data collected from the commercial vessels, will be utilized to further enhance the accuracy of image recognition. The primary focus of the project is to accurately log discards on board these vessels. Additionally, efforts are underway to establish a roadmap for the maturation, enhancement, and broader adoption of such systems within the larger Dutch and EU fleet.

9.19.3.5 Project: Gill netting in windfarms

Project Full Title: Practical assessment of the feasibility of gill netting in Dutch windfarms

Project Timeframe: 2024

Institution(s): Wageningen Marine Research, Wageningen Economic Research

Contact person: Sophie Neitzel Sophie.neitzel@wur.nl

Link(s): n.a.

Is the project directly addressing bycatch of PETS? YES

Could this project indirectly decrease bycatch of PETS? NO

Is the project addressing ALDFG? NO

Summary: With the completion of the new wind energy areas Hollandse Kust Zuid and Noord, the Netherlands currently has 9 wind farms that have been put into use. The number of wind farms in the North Sea will increase significantly in the coming years, leading to more limited space for Dutch fishing. The North Sea Agreement therefore attempts to explore possibilities for shared use by (passive) fishermen within future wind farms. Currently, trawling is not allowed in wind farms. As for alternative, so-called passive fishing techniques, it is still unclear whether

these are feasible and profitable within a wind farm. Various completed and ongoing projects focus on investigating possibilities for shared use. 'Fishing for the wind' (2016) has made an initial exploration of the possibilities and impossibilities for fishermen in wind farms. The WinWind (2019 – 2023) includes an exploration, partly in practice, into the operational aspects (safety / risk management / implementation) of sailing and working as a fisherman in wind farms. Steps are being taken, also partly in practice, to map out the feasibility of fishing for crabs and lobsters with pots within wind farms (BO-43-119.01-012 and -028). A broad inventory and organization of available (national and international) knowledge has also been carried out in a desk study (BO-43-119.01-034). Because there must be a policy regarding fishing in wind farms by 2024, research into various techniques (BO BO-43-119.01-054 and BO-43-119.01-055) looked at what (fishing technically, economically, ecologically and in terms of safety) is achievable. In the first study, two types of passive gear were examined: mechanical jigging (rigging code LHM) and different variants of pots (so-called multi-species pots, rig code FPO). In a parallel study, handline fishing (gear code LHP) and net fishing (gear code GNS) were investigated. This research focuses on additional test days within existing Borssele parks and new plots in the recently completed Hollandse Kust Zuid wind energy area, in order to have more geographical spread. The project contributes directly to MMIP E5, in which developing new revenue models in wind farms is one of the objectives. The additional knowledge about standing nets also supports this, where there are still concerns about by-catch of birds and marine mammals. and possible attraction to birds, policy in making a choice about which techniques they allow for shared use in wind farms. A final report with the results will be delivered.

Issue

This research builds on the first research that took place in Borssele I and II OWF in 2023 (hereinafter referred to as phase 2). In Phase 2, safety, technical feasibility, catches/bycatches, ecology (birds/marine mammals), economic feasibility and legal frameworks of, among other things, net fishing in the Borssele wind farm were examined. Because the number of test days was very limited due to unsuitable weather conditions and the inability to combine gears on the same ship and many test days were cancelled due to high winds and high waves, the researchers only have an indication regarding safety and fishing technical aspects. Additional research is therefore required for the rigging (rigging code GNS), to specifically look at the following points:

- Feasibility of net fishing in a wind farm (fishing technically, economically, ecologically and in terms of safety)
- Attraction to birds through net fishing activities
- Possible dragging/bottom disturbance of the anchors when retrieving the nets
- By-catches and marketable catches in net fishing

When testing this fishery, the above points are examined, and the method is recorded in an action plan and later a work protocol for on board. The catches will be recorded and analysed so that researchers can make statements at a later stage about economic feasibility and quantities of marketable catches. Special observations such as marine mammals will also be recorded.

9.19.3.6 Project: Selectivity & survival

Project Full Title: Research collaboration on reducing under sized by-catch mortality.

Project Timeframe: 2019 – September 2023

Institution(s): Wageningen Marine Research, VisNed, Nederlandse Vissersbond

Contact person: Edward Schram Edward.schram@wur.nl

Link(s): N.A.

Is the project directly addressing bycatch of PETS? NO

Could this project indirectly decrease bycatch of PETS? NO

Is the project addressing ALDFG? NO

Summary: This project aimed to develop and test gear innovations aimed at reducing fisheries mortality among undersized fish by either avoid that they are caught (increased selectivity) or increasing their survival probability when discarded. Main focus of this project is on bycatches of plaice in beam trawling for sole and quad-rigging for Norwegian lobsters and by-catches of whiting in flyshoot fisheries. The main gear innovations tested are summarized in Table 9.4.

Table 9.4. Summary of gear innovations.

Name	Aim	Mechanism	Status	Results	Future
Speed-bump panel	Reduce bycatch of undersized plaice in BT2 targeting sole	Separation of plaice and sole by a horizontal panel based on differences in escape behaviour.	Completed	Proof of principle established in lab trails. Testing in full scale has not been done.	Nothing planned
MHS	Increase discards survival probability of undersized plaice in BT2 targeting sole	The MHS is basically a 'bag of water'. In the section before the actual cod-end, a graded water flow inside is achieved with strategically positioned and sized escapement ports along the length of the cod-end to allow water and undersize catch to escape. The actual cod-end is a closed bag which allows the lifting of the fish on board while in water, minimizing the physical strain on the fish.	Completed	Trails at sea with beam trawlers with 4m and 12m wide gears showed much improved condition of discards (proxy for higher survival) while landings equalled the conventional gear.	Proposal for further development in BT2 and extension to TR2 submitted under national EMFAF.
Rubber strands	Selective and low impact stimulation of sole for BT2 fisheries, resulting in increased discards survival probabilities for mainly plaice and reduced bycatches of undersized plaice.	Reduced mechanical impact should result in higher discards survival.	Completed	Landings were lower or comparable to the conventional BT2 gear depending on the type of seafloor / fishing ground. Condition of discards caught with rubber strands was slightly better, indicating a slightly higher discards survival probability.	Nothing planned
Swedish grid	Reduce bycatch of undersized plaice in Norwegian lobster fisheries	Sorting grid separating lobsters from fish, leading fish to a second, larger meshed cod-end.	Completed	Among others: 70% reduction of bycatch of undersized plaice but also some loss in lobster landings.	Nothing planned
Flyshoot	Gain insight in species specific behavior as knowledge base for developing escape routes	Utilize differences in behavior	Completed	Under water footage collected	Nothing planned

9.19.3.7 Project: Passive shrimp fisheries

Project Full Title: Passive shrimp fisheries Waddensea

Project Timeframe: January 2024 – June 2026

Institution(s): Wageningen Marine Research

Contact person: Pieke Molenaar, pieke.molenaar@wur.nl

Link(s): na

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Brown shrimp (Crangon crangon) beam trawl fisheries in Dutch coastal waters are facing economic and ecological sustainability issues. Government, NGO's and society are demanding more sustainable brown shrimp fisheries for the future, and should aim for lower carbon emissions, minor unwanted bycatches and decreased bottom impact. This requires innovative fishery practices, may be achieved with the transition from active gear to passive fishing gears. Two possible options for passive brown shrimp fishing gears are stow net and pots. Both methods have been used in the area in the past but not to catch brown shrimps. This project investigates whether those methods offer an economically and environmentally alternative and focusses on a year-round field trial and optimalisation for both methods. Field trials are expected to start in the summer of 2024. Those trials will give insight in the catch efficiency, fuel consumption and economic viability. The results feed into an economic model that calculates or, and on what scale both methods can offer an acceptable economic alternative for the current brown shrimp beam trawl fishery.

9.19.3.8 Project: MASENRO 2.0

Project Full Title: Under water (flat)fish detection and species recognition

Project Timeframe: 2022 – 2025

Institution(s): Wageningen Marine Research, Visserij Innovatiecentrum Zuid West Nederland, Wageningen University, Vissersvereniging Zuid west Nederland

Contact person: Pieke Molenaar, pieke.molenaar@wur.nl

Link(s): na

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This project aims to develop methods for automatic species recognition, individual counts and length detection of (flat)fish on the seabed and inside trawls. First steps for fish tracking and species recognition are performed with existing underwater footage with a wide range of species from North Sea and English Channel flyshoot fisheries. If species recognition is successful, the project investigates the possibilities for under water species selection and release. Future developments will include video observations of several flatfish species (sole, plaice, turbot) in a tank environment to train automatic detection software and application on seabed video collected from commercial trawls.

9.19.4 Future projects and Ideas

9.19.4.1 Project: MHS 2.0

Project Full Title: Further development of the modular harvesting system for beam trawl and twinrig fisheries

Estimated Project Timeframe: January 2025 – December 2027

Institution(s): Wageningen Marine Research, Dutch Fishery Association

Contact person: Edward Schram, Edward.schram@wur.nl

Collaboration welcome?: Y

Funding secured?: N

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project aims to further develop the application of the MHS in demersal fisheries in the North Sea. The development within beam trawl fisheries will be continued and the project will start the development for twin rig fisheries targeting plaice. The project also aims to establish an informal international network of institutions / researchers working or planning to work on MHS. The objective of this network is to exchange knowledge and experience to advance MHS development and support its legalisation process in the EU.

9.19.4.2 Project: Squid bycatch research in North Sea and Chanel

Project Full Title: Squid research (no official name yet)

Estimated Project Timeframe: October 2023 – December 2025

Institution(s): Wageningen Marine Research

Contact person: Allard van Mens, allard.vanmens@wur.nl

Collaboration welcome?: Y

Funding secured?: NA

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: Many fishermen in the Netherlands have opportunistically switched to squid fisheries during the winter months. However, this fishery is currently unregulated and unquantified, leading to numerous knowledge gaps. The proposed research aims to address these gaps by focusing on several key areas. Firstly, it will develop stock models and management strategies to inform potential future governance of the fishery. Secondly, it will assess the economic importance of the squid fishery. Finally, the project will include a gear technology component, exploring methods to reduce discard proportions in the catch. This will involve observer trips to gather data on discards, as well as research into alternative sources of information. Additionally, the project may propose and potentially test gear modifications aimed at minimizing discard catches.

9.20 United States of America

9.20.1 Contact person

- Mark J.M. Lomeli, Pacific States Marine Fisheries Commission, mlomeli@psmfc.org
- Sally Roman, Virginia Institute of Marine Science, William & Mary, saroman@vims.edu

9.20.2 Summary

The 2024 United States of America National Report includes contributions from the NMFS Alaska Fisheries Science Center, FishNext Research, the International Pacific Halibut Commission, Ocean Associates, Inc., the Pacific States Marine Fisheries Commission, Responsible Offshore Science Alliance, The Safina Center, University of Massachusetts Dartmouth, and the Virginia Institute of Marine Science. Project summaries from these contributors are below.

- Tested two square mesh escape panels in the twine top of a scallop dredge to reduce the bycatch of yellowtail *(Pleuronectes ferruginea*) and windowpane flounder (*Scophthalmus aquosus*).
- A two row and a three row 15 cm square mesh escape panel was installed in a scallop dredge twine top and tested with a traditional scallop dredge.
- The experimental twine tops were also tested with a regulated modified scallop dredge bag, designed to reduced flounder bycatch, to determine if further reductions in catch could be achieved.

9.20.3 Projects

9.20.3.1 Using deep learning to reduce Pacific salmon (*Oncorhynchus* spp.) bycatch in trawl fisheries

Project Full Title: Automated video processing to support commercial fishing innovation in the walleye pollock (*Gadus chalcogrammus*) fishery in Alaska

Project Timeframe: March 2021 – December 2024

Institution(s): NOAA NMFS Alaska Fisheries Science Center, Pacific States Marine Fisheries Commission, Trident Seafoods

Contact person: Katherine Wilson, katherine.wilson@noaa.gov

Link(s): N/A

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes, methods developed and tested will be applicable to other trawl fisheries.

Is the project addressing ALDFG? No

Summary: Bycatch reduction devices (BRDs) are used in the walleye pollock (*Gadus chalcogrammus*) fishery in Alaska to reduce Pacific salmon (*Oncorhynchus* spp.) bycatch. The performance of BRDs is often studied by recording videos during fishing. There is also current research to develop active BRDs that use live-feed video. The recorded and live-feed video require people to review or monitor the footage, which is tedious and costly. These impediments can slow BRD development and adoption.

Deep learning techniques that automatically detect, classify, and track species of interest would significantly reduce the work load associated with reviewing or monitoring footage. This project has investigated the possibility of using deep learning object detection and tracking to identify and track pollock and salmon in Alaska commercial pollock trawls. The models that we have developed will help support a semi-automated video review process when evaluating BRDs for this fishery and automated methods for triggering active BRD that will release salmon that currently being developed for this fishery.

We evaluated the performance of two state-of-the-art object detectors (EfficientDet and YOLOv8) for detection of pollock and salmon and four object trackers (Intersection of Union, Centroid, OC-SORT, and ByteTrack) for salmon tracking. We annotated more than 17,000 video frames that included salmon and pollock tracks from footage collected over seven commercial fishing tows in the Eastern Bering Sea in 2020 and 2021. YOLOv8 models performed the best at pollock and salmon detection. The Centroid tracker performed the best at salmon tracking. Examples of detection and tracking can be seen in Figure 9.58 and Figure 9.59, respectively.

The performance achieved by both the detectors and trackers indicate that deep-learning fish detection and tracking in trawls is promising for bycatch reduction and revealed additional measures that can be used to increase performance and reliability of deep-learning models for this application.

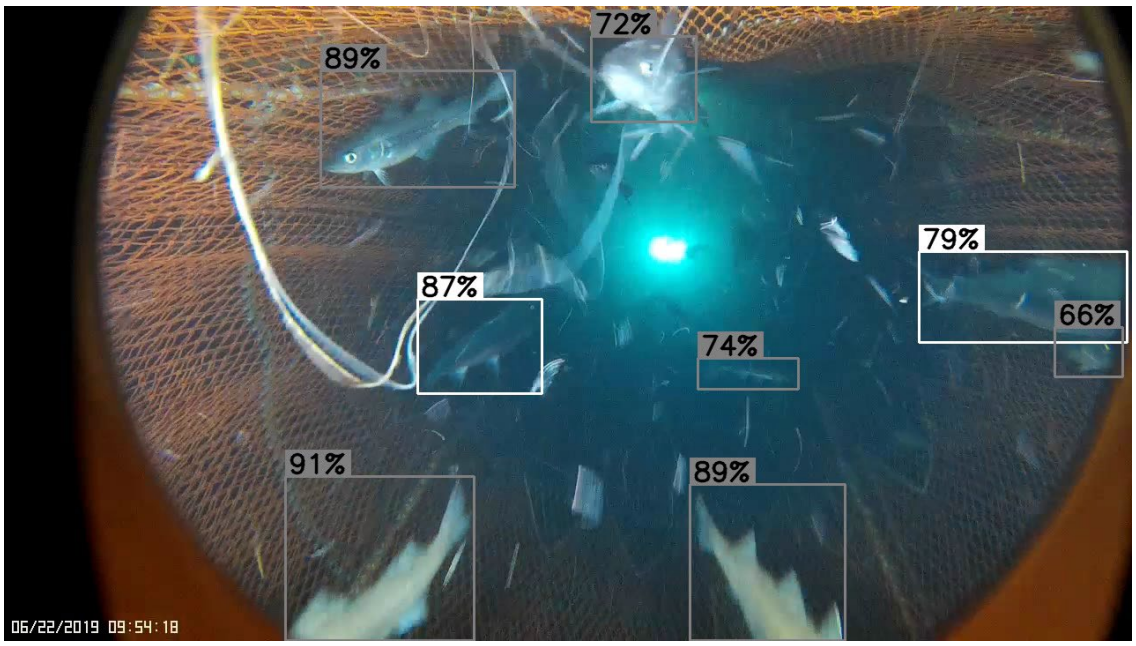


Figure 9.58. Example of YOLOv8 salmon (white) and pollock (grey) detections. The percentage shown on the top-right of the bounding box is the detection confidence score.

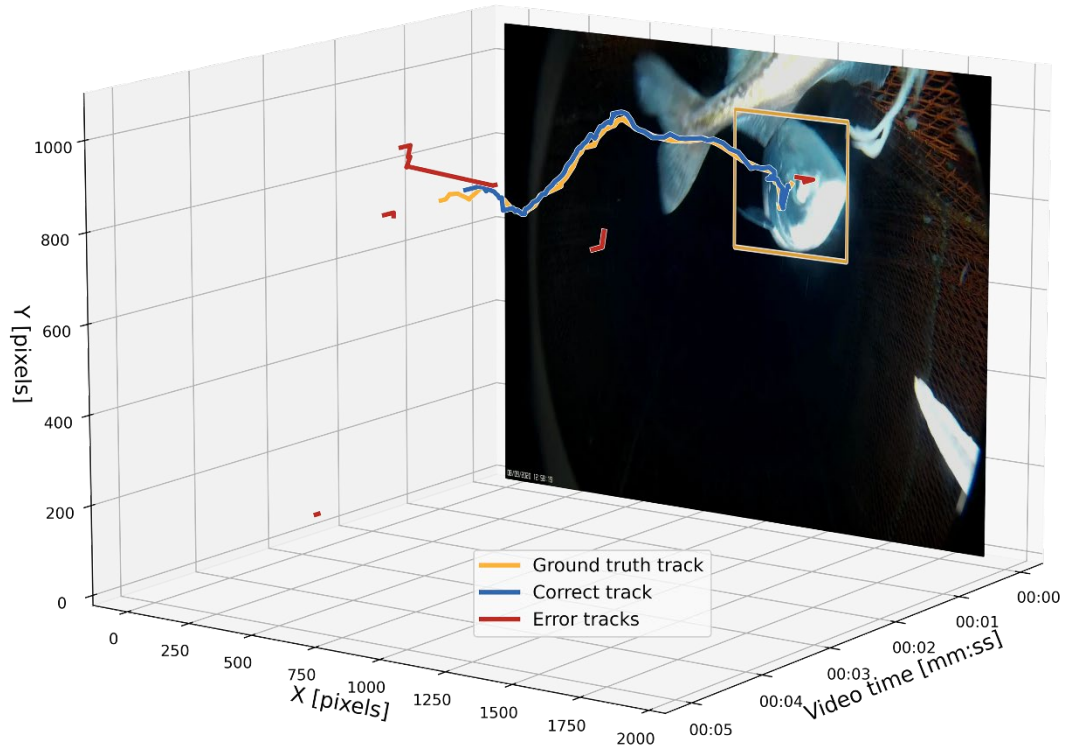


Figure 9.59. Example salmon tracking result for the centroid tracker. Predicted track centroids are plotted as a salmon moves aft in a trawl net. The correct predicted track is shown in blue, false positive tracks are in red. Initial salmon position and the ground truth track is shown in yellow.

9.20.3.2 ctive Selection (ActSel) for Trawls

Project Full Title: Improving and encouraging adoption of active selection (ActSel) systems to reduce bycatch in catch-share trawl fisheries of the North Pacific

Project Timeframe: September 2022 – August 2024

Institution(s): FishNext Research

Contact person: Craig S Rose, fishnextresearch@gmail.com

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: The availability of real-time video of fish passing through trawls motivated development of a system to release unwanted fish by triggering temporary net changes. Rose and Barbee (2022) developed and demonstrated a prototype of such an active selection (ActSel) system, that uses a hydrodynamic kite to move a net panel covering an escape portal during normal fishing (Figure 9.60, left). Moving the panel to release fish uncovers and stretches that portal and funnels fish into it (Figure 9.60, right). Initial trials during commercial fishing were frustrated by inconsistent operation, failing to quickly identify effective kite adjustments. New and improved kite designs (Figure 9.61) and adjustments were found through model trials, involving a team of fishery participants. The electromechanical actuator that adjusts the kite's control lines (Figure 9.62) was redesigned around another underwater rotator that provided continuous position control and feedback. Subsequent field trials led to a configuration providing consistent and rapid panel

shifts and useful insights for adapting the systems to new vessels. These will be applied to supporting 2024 ActSel deployments into relevant fisheries.

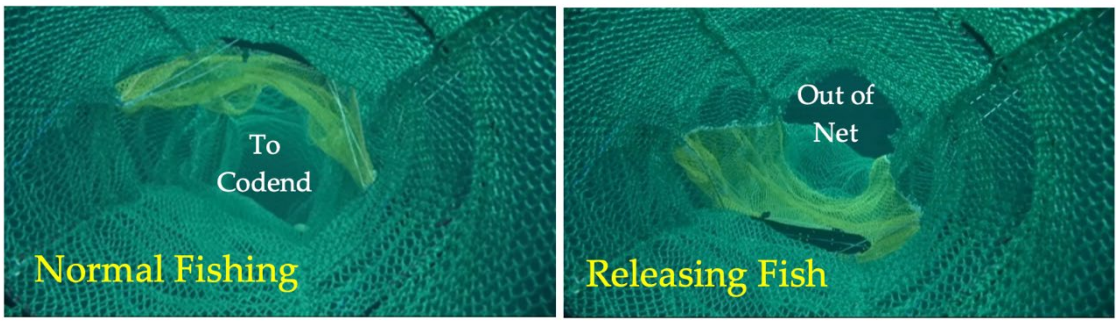


Figure 9.60. Scale model of Active Selection panel in normal fishing mode (left) and release mode (right). The yellow selection panel is driven up and down by the black kite, which is manipulated by white control lines. The lowered selection panel also pulls down the top mesh of following sections, further easing escapes.

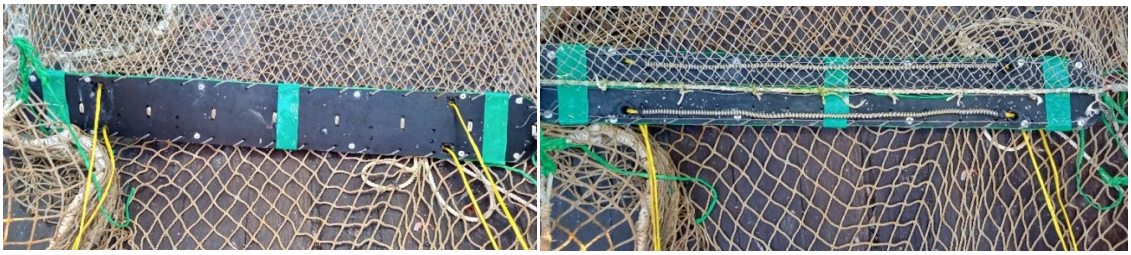


Figure 9.61. Full-scale kite (122 x 15 x 1.3 cm) in a trawl, front (left) and back (right) views. A steel coil tube on the back of the kite guides and protects the control lines.

Figure 9.62. Actuators (left) and an actuator mounted on a trawl (right An electromechanical rotator (silver) turns a reel that adjusts the lengths of kite control lines.

Publication: Rose, C.S. and D. Barbee. 2022. Developing and testing a novel active-selection (ActSel) bycatch reduction device to quickly alternate trawls between capture and release configurations with real-time triggering. Fisheries Research 254 #106380 https://doi.org/10.1016/j.fishres.2022.106380

9.20.3.3 Gear-based Hook and Line Catch Protection from Depredation

Project Full Title: Gear-based approaches to catch protection as a means for minimizing whale depredation in longline fisheries

Project Timeframe: November 2021 – October 2023

Institution(s): International Pacific Halibut Commission, National Oceanic Atmospheric Administration

Contact person: Claude Dykstra, claude.dykstra@iphc.int

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Possibly. Breaking the depredation reward cycle could lead to less interactions in and around fishing gear, thereby reducing bycatch risks to the depredators.

Is the project addressing ALDFG? No

Summary: Aim: This project will help refine potential devices that can be used in the Pacific halibut fishery to protect longline catch from damage or removal by toothed whales and to potentially interrupt the reward cycle leading to depredation.

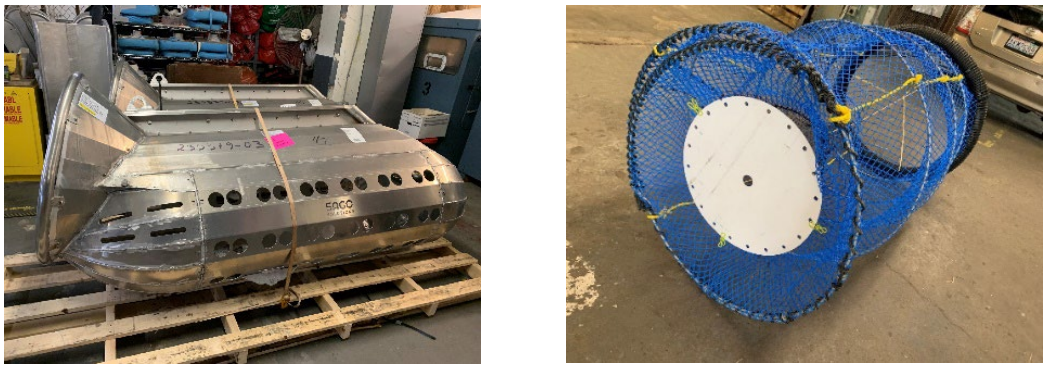
Activity: This project took a two-step approach to protecting fish already caught on hooks from marine mammal depredation: 1) Work with fishermen and gear manufacturers, via direct communication and through an international workshop, to identify effective methods for protecting hook captured flatfish from depredation; and 2) develop and pilot test simple low-cost catch-protection designs that can be deployed on vessels currently operating in the Northeast Pacific.

Rather than develop a new fishing gear or method, the goal was to generate ideas for the creation of low cost, easy to adopt gear modifications, to securely retain demersal longline catch of flatfish (e.g., Pacific halibut (*Hippoglossus stenolepis*) or Greenland turbot (*Reinhardtius hippoglossoides*)): creating additional tools for the fishermen's toolbox.

Results: The first phase of this project consisted of recruiting participants for a catch protection workshop from the scientific community and from the harvesters active in the waters off Alaska, British Columbia and the U.S. west coast and is reported on in the 2023 National Report.

Based on workshop outcomes, two catch protection prototype designs to be tested were developed: a) an underwater shuttle and b) a branch line gear with a sliding shroud system.

The underwater shuttle was modeled after a device invented by Sago Solutions, a Norwegian company. Two devices (one for testing and one for backup), that are 20% smaller (2.6m x 0.8m, 100 kg empty) than the standard units, were custom manufactured for this project (Figure 9.63A). The sliding shroud protecting branch line gear was developed after further consultations with Global Pesca, a Chilean fishing company with relevant experience. The shroud used in the design was based on a modified 'slinky' pot (a collapsible pot manufactured by FishTech Inc, USA), altered to have one end closed and the other open with a flange to help slide over the catch during haul back of the gear (Figure 9.63B). Large slinky pots (2m x ~0.75-1.0m) were used for this project.



A B

Figure 9.63. Underwater shuttles (A), and branch line shroud (B).

The purpose of the testing was to investigate (1) the logistics of setting, fishing, and hauling of the two pilot catch protection designs, and (2) the basic performance of the gear on catch rates and fish size compared to unprotected gear.

The pilot work occurred in May 2023 on a chartered 17m steel longliner (R/V *Pacific Surveyor*) offshore from Newport, Oregon, USA. Ten sets were made of each gear type, with an even number of treatments (controls or protection devices) per set. All gear was fitted with waterproof underwater lighting and camera systems. Testing was not conducted in the presence of whales.

1. **Shuttle system**. Shuttle gear had a standard fixed gear skate of 100 hooks on 5.5m (18ft) spacing, a blank half skate (on which to thread and allow the shuttle to reach the bottom before entraining catch) followed by a second skate. Gear was allowed to soak for three hours. During the hauling of gear, the shuttle was spliced onto the blank skate of gear, after which it slid down the groundline while removing fish from the hooks, before encountering the pre-installed stopper device and returning the catch to the surface enclosed within the device. Upon reaching the surface the shuttle was hoisted onto the vessel where it was opened, and the fish were released onto the deck (Figure 9.64). All fish were released immediately after sampling.

A B C

Figure 9.64. Shuttle being retrieved (A), catch entrained in shuttle (B), and catch being emptied onto the vessel deck (C).

During testing, small adjustments were made to protocols to attach the shuttle safely and efficiently to the groundline, and the introduction of smaller hooks and weaker gangions led to lower levels of damage to the entrained fish. Shuttles had good entrapment of catch, with sets

containing the shuttle yielding similar catch rates to the control sets (Figure 9.65A), as well as similar size fish compared to the entrained catch (Figure 9.65B).

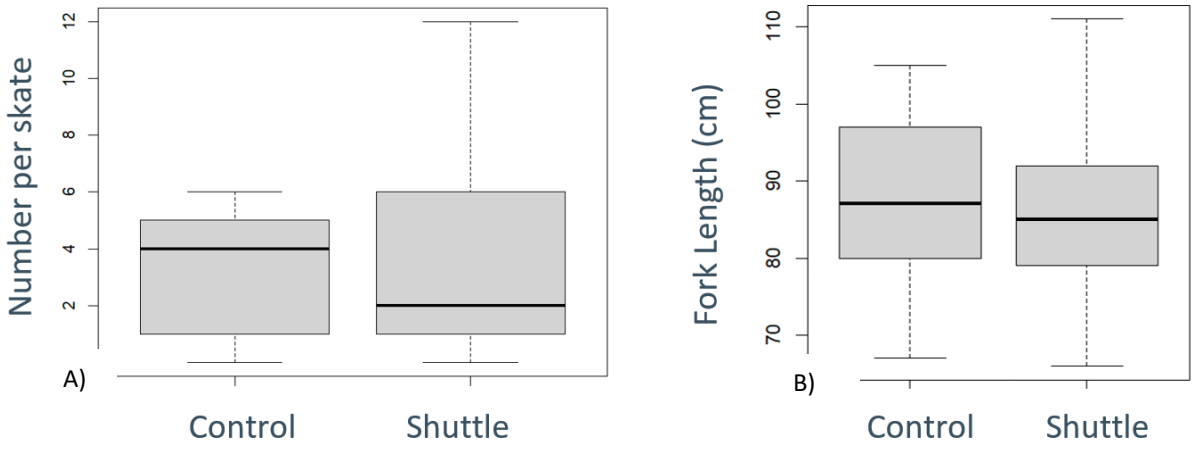


Figure 9.65. Number of individuals (A), and fork lengths (B) of Pacific halibut recovered per skate of control gear or retrieved by the shuttle.

2. **Shrouds on branch line system**. Shroud treatments initially consisted of a shortened skate of groundline (180m (591ft)), to which six 15m (48ft) branch lines (each with 10 hooks snapped on 1.2m (4ft) spacing) were attached. Three branches included shrouds to cover the catch, and three control branches had no protective shroud. During testing this was reduced to two protected and two control branches, all with 0.6m (2ft) spacing to provide more handling time and to reduce risk to crew. Shrouds were deployed during the setting of the gear and were activated to slide down to cover the gear during the hauling/retrieval (Figure 9.66) of the gear.

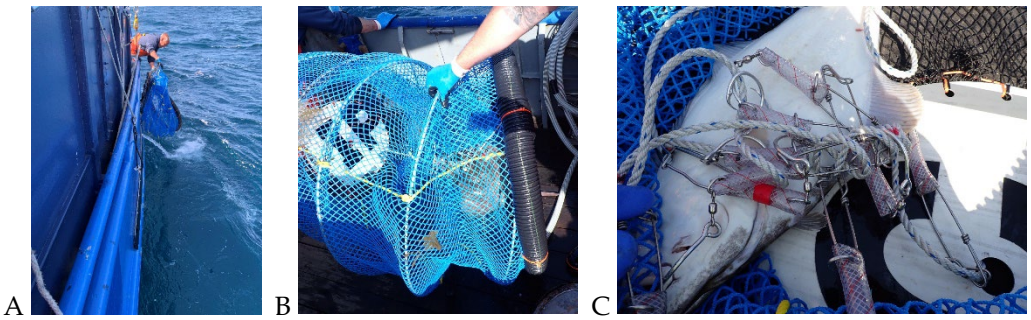


Figure 9.66. Shroud gear being retrieved (A), longnose skate covered by the shroud (B), and a Pacific halibut along with clustered hooks covered by the shroud (C).

Real time adjustments in gear design and setting methods allowed for safe deployment of the branch lines and shrouds. The changes resulted in a very small effective fishing footprint of the gear on the bottom, which combined with high Pacific hagfish (*Eptatretus stoutii*) activity (reducing bait longevity/availability) resulted in minimal catch with which to make comparisons between controls and treatments. It was concluded that several logistical issues would need to be improved to scale this up to commercial fishing and that even if logistics could be refined, the shrouds would conceivably still avail depredation opportunities to whales at the exposed end of the shroud.

This project was funded in part by the National Oceanographic and Atmospheric Administration's Bycatch Engineering and Reduction Program (BREP) project number NA21NMF4720534.

Future: Additional BREP funding has been secured to conduct further testing of the shuttle device in the presence of depredating killer whales (*Orcinus orca*). Field work is planned for late 2024 or 2025 dependent upon vessel availability.

9.20.3.4 Reducing Whale Entanglement Risk Using Weak Rope

Project Full Title: Optimizing the Implementation of Whale-Release (1700lbf Breaking Strength) Ropes to Reduce Large Whale Entanglement Risk

Project Timeframe: August 1, 2022 – July 31, 2024

Institution(s): Ocean Associates, Inc., New England Aquarium, Tension Technology International

Contact person: Tim Werner, timothy.werner@umb.edu

Link(s): www.bycatch.org

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This project is quantifying the risk reduction to a large whale--in particular the North Atlantic right whale (*Eubalaena glacialis*)--from entanglement in pot lines, by simulating entanglement outcomes when using whale-release ropes versus regular strength ropes in different configurations. A tailored version of *OrcaFlex* software was used to create an anatomically accurate and digital representation of right whale (Figure 9.67), and to develop a program that simulates interactions between whales and ropes used in pot fisheries, specifically buoy lines (Figure 9.68). Our project's objectives are to: 1) Add in an open-closing mouth component to the whale model previously developed; 2) Reverse engineer known entanglement outcomes and incorporate different whale behaviors to define which ones lead to the types of observed entanglement configurations observed; 3) For each reverse engineered case study, conduct simulations using the most biologically informed placement of weak links (every 40 feet) and compare the "best" and the "worst" outcomes; 4) Conduct simulations, using these above findings and metrics, of four different weak rope options, some of which have been defined in NOAA's Final Rule to quantify risk reduction for each measure; 5) Compare different weak link insertions versus fully formed 1700 lbf ropes to see if there are differences in the outcomes observed; 6) Vary the elasticity of ropes based on measurements of actual NMFS-approved whale-release ropes and commonly used vertical lines that integrate weak properties, and then run scenarios in the model using different rope properties to understand how this variable influences the outcomes; 7) Review available sets of data of vertical line tensions to ground truth the *OrcaFlex* model and share our findings with fishermen on tensions of different gear types and configurations; and 8) Provide NOAA with details about change in risk with different weak rope properties and configurations for integration into their decision support tool for right whale bycatch reduction.

The scenarios run suggest that the highest endline tensions were associated with the lower section of endline between the whale and first crustacean pot which is tied together with several other pots using a groundline. The upper section of the endline had significantly lower loads largely resulting from fluid loading on the line and surface buoy. The example shown in Figure 9.69 demonstrates endline tensions for a 20-pot "trawl" (string of pots tied together with groundline) which exceeded the specified weak link limit (7.56kN).

Initial simulations indicated that the likelihood and severity of entanglement (and subsequently the magnitude of endline tensions) are highly dependent on the sequence of whale motions and contact depth. As rolling is a common initial response to entanglement, it was decided to focus on the quantifying endline tensions during roll-only motions. This led to extremely low (<1kN) endline tensions, primarily because the lower portion of the endline kept sliding off of the conical head geometry. To prevent this from occurring forward motion (0.5m/s) was implemented and these simulations are currently running.

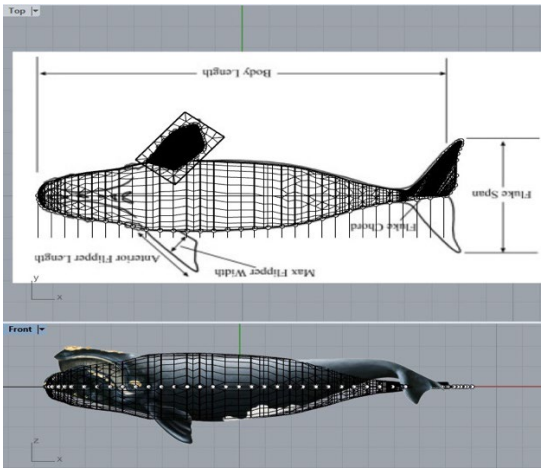


Figure 9.67. Rhino3D screenshot showing a representation of a right whale used in the computer model and incorporating actual anatomical measurements taken from an intact whale carcass.

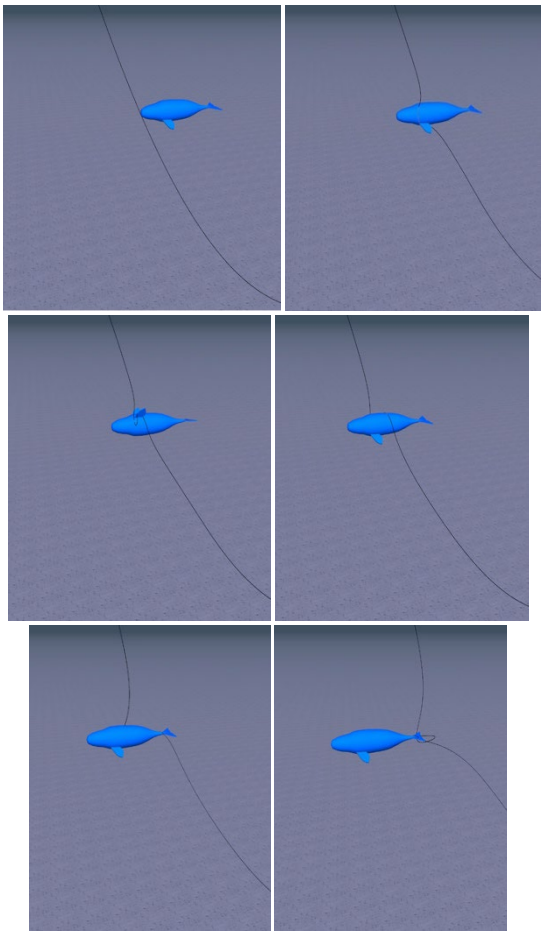


Figure 9.68. A visual representation of a whale entanglement in which the whale first encounters the rope at its head and then initiates a rolling motion in order to shed the gear. This behavior shows how the animal can become entangled at its peduncle, similar to several actual entanglements documented by emergency responders.

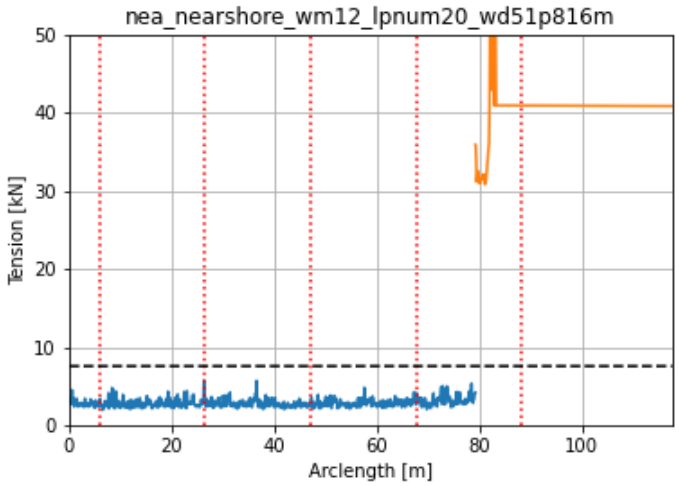


Figure 9.69. Example simulation with randomly assigned motions and 20-pot lobster trawl. Maximum endline tensions in the upper and lower sections of the endline (blue and orange lines respectively) with weak link tension limit (dashed black line).

9.20.3.5 Continued hook appendage research

Project Full Title: Further testing of modified hooks to reduce bycatch of yelloweye rockfish and Pacific spiny dogfish in a Pacific halibut longline fishery

Project Timeframe: September 2023 – January 2025

Institution(s): Pacific States Marine Fisheries Commission, Oregon State University Marine Resource Management program and Cooperative Institute for Marine Ecosystem and Resources Studies, International Pacific Halibut Commission, National Oceanic Atmospheric Administration Northwest Fisheries Science Center

Contact person: Mark J.M. Lomeli, mlomeli@psmfc.org

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This study seeks to further examine circle hooks modified with an appendage extending outwards from the hooks shank as a technique to reduce bycatch of yelloweye rockfish (Sebastes ruberrimus) and Pacific spiny dogfish (Squalus suckleyi) in the West Coast longline fishery for Pacific halibut (Hippoglossus stenolepis). Appendages positioned on the hooks offset and non-offset side (Figure 9.70) will be examined to determine if appendage position affects catch efficiency. Further, we will gather data on hooking locations to estimate modes of capture and to assess the likely rate of discard mortality, and use hook timers to test for differences in the time of capture between Pacific halibut and bycatch species. Gear trials are scheduled to begin early-June 2024. Funding for this research was provided by the NOAA Bycatch Reduction Engineering Program (Award# NA23NMF4720416)

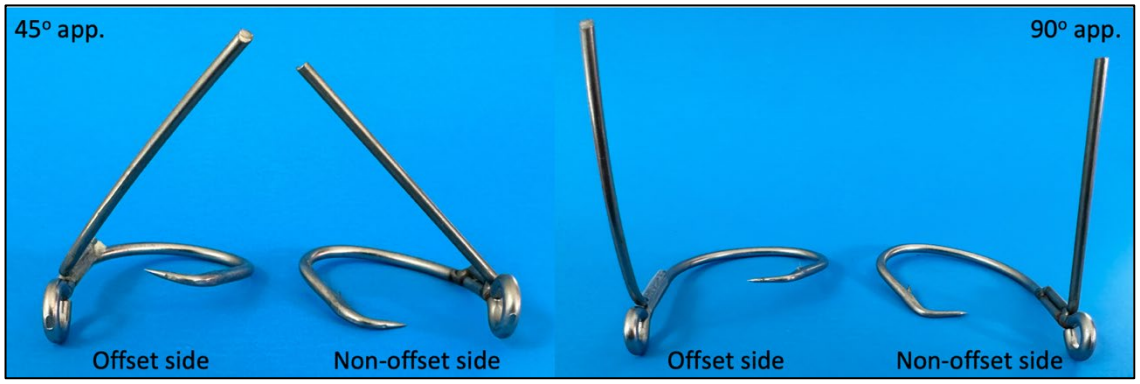


Figure 9.70. Images comparing 45o and 90o appendages (app.) extending outwards from the hooks shank on the hooks offset and non-offset side.

9.20.3.6 Evaluating the vertical distribution of Pacific halibut as they enter a groundfish trawl

Project Full Title: Evaluating the effect of artificial illumination on the vertical distribution of Pacific halibut as they enter trawls an its application for bycatch reduction

Project Timeframe: September 2023 – December 2024

Institution(s): Pacific States Marine Fisheries Commission, Oregon State University Marine Resource Management program and Cooperative Institute for Marine Ecosystem and Resources Studies, International Pacific Halibut Commission, National Oceanic Atmospheric Administration Northwest Fisheries Science Center

Contact person: Mark J.M. Lomeli, mlomeli@psmfc.org

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This study looks to quantify the degree that Pacific halibut (Hippoglossus stenolepis) vertically separate from target groundfishes when entering a groundfish trawl with illuminated and non-illuminated upper bridles and its potential application for bycatch reduction. To explore for vertical separation between Pacific halibut and groundfishes upon entering the trawl, we will install a horizontal separator panel ~2 m above the trawls belly in a trawl with a headrope height of ~4.5 m. The catch data will be analyzed using catch comparison and catch ratio analyses. Gear trials are scheduled to begin late-July 2024. Funding provided by the NOAA Northwest Fisheries Science Center Cooperative Research Program (Award # NA22NMF4370355).

9.20.3.7 Testing of a semi-demersal longline to reduce bycatch

Project Full Title: Testing of semi-demersal longlines to reduce yelloweye rockfish bycatch in the West Coast directed Pacific halibut longline fishery

Project Timeframe: September 2022 – August 2024

Institution(s): Pacific States Marine Fisheries Commission, Oregon State University Marine Resource Management program and Cooperative Institute for Marine Ecosystem and Resources Studies, International Pacific Halibut Commission, National Oceanic Atmospheric Administration Northwest Fisheries Science Center

Contact person: Mark J.M. Lomeli, mlomeli@psmfc.org

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This study examined how changing from a conventional demersal longline to an experimental semi-demersal longline effects the catch efficiency of yelloweye rockfish (Sebastes ruberrimus) in the West Coast Pacific halibut (Hippoglossus stenolepis) longline fishery. Our catch ratio analysis showed the semi-demersal longline only caught 61% of what the demersal longline is catching for fish >47 cm in length. This result was significant. However, a catch reduction of Pacific halibut was also observed for the semi-demersal longline gear. Here, the semi-demersal longline only caught 51% of what the demersal longline gear was catching for fish 88-110 cm in length. Use of hook timers showed the time of capture between Pacific halibut and yelloweye rockfish did not differ statistically. Further, the data showed the majority (>75%) of individuals for both species were caught within 2.5 hours of the gear being deployed. In terms of hooking location, the predominant hooking location was "cheek" for Pacific halibut and yelloweye rockfish for both longline gear types. Funding provided by the NOAA Northwest Fisheries Science Center Cooperative Research Program (Award #NA22NMF4370330).

9.20.3.8 Co-Design Solutions for U.S. Floating Offshore Wind Farms and Fishing Compatibility

Project Full Title: Co-Design Solutions for U.S. Floating Offshore Wind Farms and Fishing Compatibility

Project Timeframe: June 2024 – June 2026

Institution(s): Responsible Offshore Science Alliance, National Renewable Energy Laboratory, University of Maine

Contact person: Mike Pol, mike@rosacience.org

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Yes

Is the project addressing ALDFG? No

Summary: This project aims to develop novel floating offshore wind array design concepts through a co-design process with U.S. commercial and recreational fishermen to optimize co-existence of floating wind farms and fishing activities. Expert fishermen will provide information on three-dimensional use of ocean space for fixed gear, pelagic longline, and recreational fishing. This information will be used by design engineers to attempt to optimize variables such as turbine spacing, anchoring, cable moorings, and cable routes.

9.20.3.9 Exploring odontocete depredation rates in a pelagic longline fishery

Project Full Title: Exploring odontocete depredation rates in a pelagic longline fishery

Project Timeframe: Completed

Institution(s): The Safina Center

Contact person: Eric Gilman, EGilman@utas.edu.au

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Several odontocete species depredate catch and bait from fishing gear, resulting in their bycatch and causing substantial economic costs. There are no known mitigation methods for odontocete depredation in pelagic longline fisheries that are effective, do not harm odontocetes and are commercially viable. Understanding odontocetes' depredation strategies can contribute to mitigating this human-wildlife conflict. Using observer data from the Hawaii-based tuna longline fishery, this study summarized teleost and elasmobranch species-specific mean posterior odontocete depredation rates using a simple Bayesian binomial likelihood estimator with a Bayes-Laplace prior. Depredation rates of species with sufficient sample sizes ranged from a high of 1.2% (1.1 to 1.3 95% highest posterior density interval or HDI) for shortbill spearfish to a low of 0.002% (0.001 to 0.003 95% HDI) for blue shark. Depredation of catch is a rare event in this fishery, occurring in about 6% of sets. When depredation did occur, most frequently odontocetes depredated a small proportion of the catch, however, there was large variability in depredation rates between teleost species. For example, bigeye tuna was two times more likely to be depredated than yellowfin tuna (odds ratio=2.03, 95% CI: 1.8-2.3, P<0.0001). For sets with depredation, 10% and 2% of sets had depredation of over half of the captured bigeye tuna and combined teleosts, respectively. All elasmobranch species had relatively low depredation rates, where only 7 of almost 0.5M captured elasmobranchs were depredated. Odontocetes selectively depredate a subset of the teleost species captured within sets, possibly based on net energy value, chemical, visual, acoustic and textural characteristics and body size, but not median length, which was found to be unrelated to depredation rate (Pearson's r= 0.14, 95% CI: -0.26 to 0.50,

p=0.49). Study findings provide evidence to support the identification and innovation of effective and commercially viable methods to mitigate odontocete depredation and bycatch.

Publication: *PLoS ONE* 19(3): e0301072.

9.20.3.10 Evidence from interpretable machine learning to inform spatial management of Palau's tuna fisheries

Project Full Title: Evidence from interpretable machine learning to inform spatial management of Palau's tuna fisheries

Project Timeframe: Completed

Institution(s): The Safina Center

Contact person: Eric Gilman, EGilman@utas.edu.au

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Static and dynamic area-based management tools hold substantial potential to balance socioeconomic benefits derived from fisheries and costs from bycatch mortality of at-risk species. Palau longline fisheries have high bycatch of at-risk species including the olive ridley marine turtle and silky and blue sharks. This study analyzed a two decades-long time series of observer and electronic monitoring datasets from the Palau distant-water and locally-based pelagic longline fisheries. An interpretable or explainable machine learning based modelling approach was used to derive spatially-resolved species-specific catch rate predictions. These models were conditioned on a suite of potentially informative environmental, bathymetric, ocean climate metric, vessel, monitoring system and set-specific operational predictors. Overall, there would be limited ecological tradeoffs from focusing fishing effort within primary catch rate hotspots for target bigeye and yellowfin tunas. Mean field prediction surfaces also defined catch rate hotspots for at-risk species of silky and blue sharks, olive ridley turtle and pelagic stingray, which did not overlap the hotspots for target species. The predicted target species hotspots, however, overlap olive ridley and pelagic stingray warmspots. Results also identify opportunities for temporally dynamic spatial management to control catch rates of target and bycatch species. Management of fishery operational predictors of fishing depth and soak duration present additional opportunities to balance catch rates of at-risk bycatch and target species. A transition to employing fleetwide or vessel-based output controls that effectively constrain the fishery would alter the spatial management strategy to focus on zones with the lowest ratio of at-risk bycatch to commercial catch. Our findings support evidence-informed evaluation of spatial management strategies and complementary measures to meet objectives for balancing socioeconomic benefits derived from target species catch with costs to threatened species.

Publication: *Ecosphere* doi: 10.1002/ecs2.4751.

9.20.3.11 Synthesizing a network of evidence on a seabird bycatch mitigation measure prescribed by regional fisheries management organizations

Project Full Title: Synthesizing a network of evidence on a seabird bycatch mitigation measure prescribed by regional fisheries management organizations

Project Timeframe: In progress

Institution(s): The Safina Center

Contact person: Eric Gilman, EGilman@utas.edu.au

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Robust estimates of the relative efficacies of alternative management interventions are essential to support evidence-informed policy. Fisheries bycatch is a major threat to the conservation of albatrosses, large petrels and other pelagic seabirds. Managing branchline weighting designs is one approach to reduce seabird bycatch in pelagic longline fisheries that also supports flexible compliance monitoring. Variability in the mass of weights and distance between the weight and hook affects seabird catch risk. Different branchline weighting designs are prescribed by regional fisheries management organizations (RFMOs) and the Agreement on the Conservation of Albatrosses and Petrels. This study undertook the first global synthesis of accumulated evidence of seabird bycatch rate responses to alternative weighting designs. We conducted a systematic literature review and assembled a dataset suitable for a global meta-synthesis based on a Bayesian multilevel network meta-regression modelling approach to assess the relative efficacies of alternative weighting designs and other potentially informative predictors for mitigating seabird bycatch in pelagic longline fisheries. Some prescribed designs had significantly different relative seabird catch risk: Of 10 possible pairwise contrasts of 5 prescribed weighting designs, 4 had >92% probabilities of having significantly different seabird catch rates. All six designs were significantly more effective than a reference design of no weight within 4m of hooks, ranging from 62% (95% QCI: 46-99) to 89% (95% QCI: 66-98) lower seabird catch rates (≥0.97 probabilities of lower seabird catch rates). Findings provide evidence for robust evaluation of alternative regional seabird bycatch management strategies.

9.20.3.12 Trial of sliding branchline weights for pelagic longline vessels

Project Full Title: Trial of sliding branchline weights for pelagic longline vessels

Project Timeframe: In progress

Institution(s): The Safina Center

Contact person: Eric Gilman, EGilman@utas.edu.au

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: Seabird bycatch is problematic in pelagic longline fisheries. Attaching weights closer to hooks increases the hook's sink rate, which reduces seabird catch risk. The safety risk to crew from attaching branchline weights close to hooks, when monofilament leaders are used, is lower when sliding weights are used compared to conventional lead-centered swivels that are crimped onto branchlines. Vessels from Hawaii, Taiwan and Japan longline fisheries are participating in a demonstration of fishing with 60g sliding weights attached within 1m of the hook to assess practicality, safety and economic viability relative to conventional line weighting designs with weights attached with longer leader lengths.

9.20.3.13 HD camera for monitoring scallop dredge

Project Full Title: *In Situ* high-definition camera monitoring to evaluate catch efficiency and performance of a survey dredge

Project Timeframe: January 2019 – December 2023

Institution(s): University of Massachusetts Dartmouth, School for Marine Science and Technology (in collaboration with Virginia Institute of Marine Science)

Contact person: Chris Rillahan, Crillahan@umassd.edu

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project was to conduct in situ observation and monitoring of a sea scallop survey dredge to understand and evaluate its catch efficiency and selectivity under different habitat conditions. High-definition video cameras equipped with synchronized strobe lights was used to document size and density of scallop in front of the dredge. An inclinometer was placed on the survey dredge to measures dredge tilt angle and bottom contact. Together with bag sampling, dredge efficiency, selectivity, saturation and other aspects of dredge performance across a range of habitat types and survey conditions (i.e., densities of scallops and debris) were determined. Information on bycatch species were also collected in an effort to estimate species-specific dredge efficiency estimates. Dredge catch efficiency was reduced in high scallop densities areas.

9.20.3.14 Fish behaviour and Distribution around Offshore Wind Farms

Project Full Title: Connectivity, Movement and Distribution of Fish in Offshore Wind Farm Areas

Project Timeframe: January 2023 – December 2025

Institution(s): University of Massachusetts Dartmouth, School for Marine Science and Technology

Contact person: Pingguo He, phe@umassd.edu

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The project combines acoustic telemetry, stationary bottom and midwater stereo cameras (spaced at different distances from the turbines), and an acoustic imaging sonar camera (ARIS, capable of observation at night) to study connectivity, movement and spatial distribution (vertical and horizontal) of three commercially and recreationally important fish species (black sea bass, striped bass and summer flounder) in the Block Island Wind Farm area off Rhode Island, USA. The study intend to address if there is connectivity for some species between turbines and if this results in a larger impact to ecosystems than if impacts are localized to an individual turbine. Video cameras were placed at locations of different distances from the base of the wind turbine at 50, 100, 200 and 450 m, and on the seabed and midwater. The study will improve our understanding on changes in fish distribution near wind turbines and ecosystem interactions of fish with offshore wind farms.

9.20.3.15 Incorporating Machine Learning into Electronic Monitoring Programs to Quantify Discards

Project Full Title: Incorporating Machine Learning into the NE Multispecies Groundfish Electronic Monitoring Programs to Quantify Species and Sizes of Discards

Project Timeframe: January 2021 – December 2023

Institution(s): University of Massachusetts Dartmouth, School for Marine Science and Technology

Contact person: Pingguo He, phe@umassd.edu

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: The UMass Dartmouth School for Marine Science and Technology (SMAST) has partnered with the leading cloud-based electronic monitoring company, Integrated Monitoring Inc. (IM), the nation's largest at-sea observer company, AIS Inc. and the local groundfish trawl vessels to develop and incorporate AI and machine learning tools onboard high-volume groundfish vessels in New England, USA. The goal is to reduce the cost of EM programs with AI technology that improves the operational efficiency, accuracy, and timeliness of EM discard data for science and management. The project will develop a new automated discard chute system with integrated cameras and lights to automatically identify, count, measure, and estimate volume/weight of sub-legal groundfish that is to be discarded in real time.

9.20.3.16 Intelligent Discard Chute

Project Full Title: Developing an Innovative Electronic Monitoring Program for New England GF by Integrating an Intelligent Discard Chute for High Volume Discards

Project Timeframe: November 2022 – May 2024

Institution(s): University of Massachusetts Dartmouth, School for Marine Science and Technology

Contact person: Pingguo He, phe@umassd.edu

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This project is to test an intelligent discard chute to compliment electronic monitoring for high-volume New England groundfish industry, extending from laboratory to the field. The project will incorporate high technology optical system, and artificial intelligence to document species and sizes of fish that is being discarded from the fishery. The project collaborates between a fishery observer enterprise, an electronic monitoring enterprise, SMAST and College of Engineering at the University of Massachusetts Dartmouth. The project install and test 3 – 4 systems on board commercial vessels and will evaluate their performance and acceptability by the industry and fishery manager.

9.20.3.17 Fish attraction to light

Project Full Title: Understanding mechanism and parameters of fish attraction to light

Project Timeframe: Spring 2022 (ongoing)

Institution(s): University of Massachusetts Dartmouth, School for Marine Science and Technology

Contact person: Pingguo He, phe@umassd.edu

Link(s): N/A

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This project is to understand attraction of light of different color for local marine species, and mechanism of fish attraction to light. Field work includes observations using optical and acoustic cameras to evaluate preference of color of light for local species, including scup (*Stenotomus chrysops*) and black seabass (*Centropristis striata*). The laboratory component will test the attraction of scup to light in filtered water and when zooplankton were added to the tank. It is hypothesized that it may not be the light itself that fish are attracted to but the animals in the lower food chain such as zooplankton which are attracted to the light. The findings may explain seasonal and spatial variability in fish attraction to light.

9.20.3.18 Modified Twine Top as a Tool to Reduce Bycatch in the Sea Scallop Dredge Fishery

Project Full Title: Modified Twine Top as a Tool to Reduce Bycatch in the Sea Scallop Dredge Fishery

Project Timeframe: March 2023-April 2025

Institution(s): Virginia Institute of Marine Science

Contact person: Sally Roman, saroman@vims.edu

Link(s): https://www.vims.edu/research/units/centerspartners/map/comfish/scallop/index.php

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This project builds off results from a previous project conducted in 2022. The Virginia Institute of Marine Science tested the effectiveness of a square mesh escape panel in the twine top of a scallop dredge to reduce bycatch in the sea scallop dredge fishery. Three cruises were conducted in what is referred to as Closed Area II on eastern Georges Bank in the Northwest Atlantic from August through November 2023, in collaboration with the F/V *KATE* and its commercial crew. This is an important resource area for the fishery. The fishery has limited access to the area because of high catch rates of yellowtail and windowpane flounder at certain times of the year. Management measures (gear restrictions and area closures) are already in place to mitigate catches of these flatfish; however, there is a need to further reduce bycatch as the fishery has exceeded its annual catch limit of windowpane flounder since 2017. In an effort to minimize bycatch of flatfish, a modified scallop dredge with a five-row apron and 1.5 to 1 hanging ratio for the twine top is required during certain times of the year in Closed Area II. The traditional scallop dredge has a seven-row apron and a 2 to 1 hanging ratio for the twine top.

Two 15 cm square mesh escape panels were tested on the scallop dredge. The first square mesh panel was a two-row panel; this configuration was tested during the first cruise. On the second cruise, a three-row panel square mesh panel was tested (Figure 9.71). Both escape panel

configurations were tested with a traditional scallop dredge. Based on catch results from the first two cruises, the escape panel with the greatest reduction in flatfish catch and minimal loss of scallop catch, was tested with the five-row apron modified scallop dredge on the third cruise. Catch data showed the two-row escape panel had a greater reduction in windowpane catch with no loss of commercial sized scallops.

Results indicated the greatest reduction in windowpane flounder catch (eight percent) occurred with the two-row square mesh escape panel and a seven-row apron dredge. Yellowtail flounder catches were low due to stock conditions and fish were only encountered on the third cruise. We observed both windowpane and yellowtail flounder swimming out of the escape panels. Video of the twine top escape panels was recorded with Safety Net Technology's Catch Cam. Length-based retention models were developed with the Selfisher package in R. The models for windowpane and yellowtail flounder indicated length-based behavioural differences between the two species.

Scallop catch was affected by both the number of rows in the escape panel and the number of rows in the dredge apron. The highest catches of scallops, across the length range were observed, was in the experimental two-row escape panel five-row apron dredge. The traditional dredge (i.e., seven-row apron) with either escape panel configuration had lower catches. The three-row escape panel trial had the lowest catch of scallops across the three treatments. The two-row escape panel with had lower catches of scallops less than 90 mm, with an increase in catch of scallops greater than 125 mm compared to the control dredge.

Figure 9.71. Images of the seven-row apron dredge with the two-row square mesh escape panel (top) and three-row square mesh escape panel (bottom).

9.20.4 Future projects and Ideas

9.20.4.1 Using deep learning to reduce Pacific salmon (Oncorhynchus spp.) by-catch in trawl fisheries

Project Full Title: The evaluation of camera positions to support detection of rarely occurring fish species in high volume, commercial trawls

Estimated Project Timeframe: November 2024 – November 2025

Institution(s): International Pacific Halibut Commission, National Oceanic Atmospheric Administration (NOAA)

Contact person: Claude Dykstra, claude.dykstra@iphc.int

Link(s): N/A

Collaboration welcome?: Y

Funding secured?: N

Is the project directly addressing bycatch of PETS? Yes

Could this project indirectly decrease bycatch of PETS? Yes, methods developed and tested will be applicable to other trawl fisheries.

Is the project addressing ALDFG? No

Summary: In two of the largest fisheries in the U.S., the Alaska pollock (*Gadus chalcogrammus*) and West Coast Pacific whiting (*Merluccius productus*) midwater trawl fisheries, bycatch of Pacific salmon (*Oncorhynchus* spp.) is of great concern. Although significant effort is made to reduce salmon bycatch, further work is needed. Commercial midwater tows can last for hours, and the captain and crew may not always know if and how many salmon are mixed within their catch during this time. Early, real time detection of salmon within a tow could be an additional tool that allows captains to reduce their salmon bycatch. In this project, we will advance our work to capture video inside of Alaska pollock commercial trawls and use it to train deep learning detection and tracking algorithms to count salmon. We aim to evaluate different camera set-ups for trawls and determine the optimal setup to achieve highly accurate and reliable detections of rare, bycaught species like salmon in high-volume commercial trawl fisheries like Alaska pollock. We have a funding proposal to support data collection for this project in the Alaska pollock fishery in 2025 currently being reviewed. If it is supported our data collection will take place in the summer of 2025 and the analysis will be completed through summer of 2026. If additional support can be obtained, we are interested in expanding this work to the West Coast Pacific whiting fishery and working towards integrating and testing the models in real-time camera systems and bycatch reduction devices for these fisheries.

9.20.4.2 Full scale testing of devices to minimize depredation in longline fisheries

Project Full Title: Full scale testing of devices to minimize depredation in longline fisheries

Estimated Project Timeframe: November 2023 – April 2025

Institution(s): International Pacific Halibut Commission, National Oceanic Atmospheric Administration (NOAA)

Contact person: Claude Dykstra, claude.dykstra@iphc.int

Link(s): N/A

Collaboration welcome?: Y

Funding secured?: Y, NOAA BREP Award: NA23NMF4720414

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? Possibly. Breaking the depredation reward cycle could lead to less interactions in and around fishing gear, thereby reducing bycatch risks to the depredators.

Is the project addressing ALDFG? No

Summary: Testing of catch protection shuttles was successfully demonstrated in 2023. Full scale testing in the presence and absence of killer whales (*Orcinus orca*) in the Aleutian Islands or southern Bering Sea is planned. Gear will be tested on forty sets over a ten-day research trip. The work will further investigate the logistics of (1) setting, fishing, and hauling an underwater shuttle catch protection device and (2) investigate the basic performance of the gear on catch rates and fish size compared to traditional gear. Much larger sample sizes for comparison of catch-rates and fish size than achieved in the 2023 work is anticipated.

9.20.4.3 Testing of modified hooks to reduce bycatch

Project Full Title: Continued Research on Modified Circle Hooks Designed to Reduce Bycatch in a Pacific Halibut Fishery

Estimated Project Timeframe: September 2024 – January 2026

Institution(s): Pacific States Marine Fisheries Commission, Oregon State University Marine Resource Management program and Cooperative Institute for Marine Ecosystem and Resources Studies, International Pacific Halibut Commission, National Oceanic Atmospheric Administration Northwest Fisheries Science Center

Contact person: Mark J.M. Lomeli, mlomeli@psmfc.org

Link(s): N/A

Collaboration welcome?: Y

Funding secured?: Y

Is the project directly addressing bycatch of PETS? No

Could this project indirectly decrease bycatch of PETS? No

Is the project addressing ALDFG? No

Summary: This future project in the West Coast Pacific halibut (*Hippoglossus stenolepis*) longline fishery will compare a control hook (no appendage present) to three experimental hooks that have an appendage length of either 3.8, 7.6, or 11.4 cm extending 45° from their shank (Figure 9.72) and evaluate their ability to reduce bycatch of yelloweye rockfish (*Sebastes ruberrimus*) and Pacific spiny dogfish (*Squalus suckleyi*). Conventional 16/0 sized circle hooks will be used. Further, hook timers (Figure 9.73) will be used to examine species-specific timing of interaction with longline gear as this is a critical factor for interpreting the effect of gear saturation when analyzing catch rates. Gear trials for this study will occur in 2025. Funding provided by the NOAA Northwest Fisheries Science Center Cooperative Research Program.

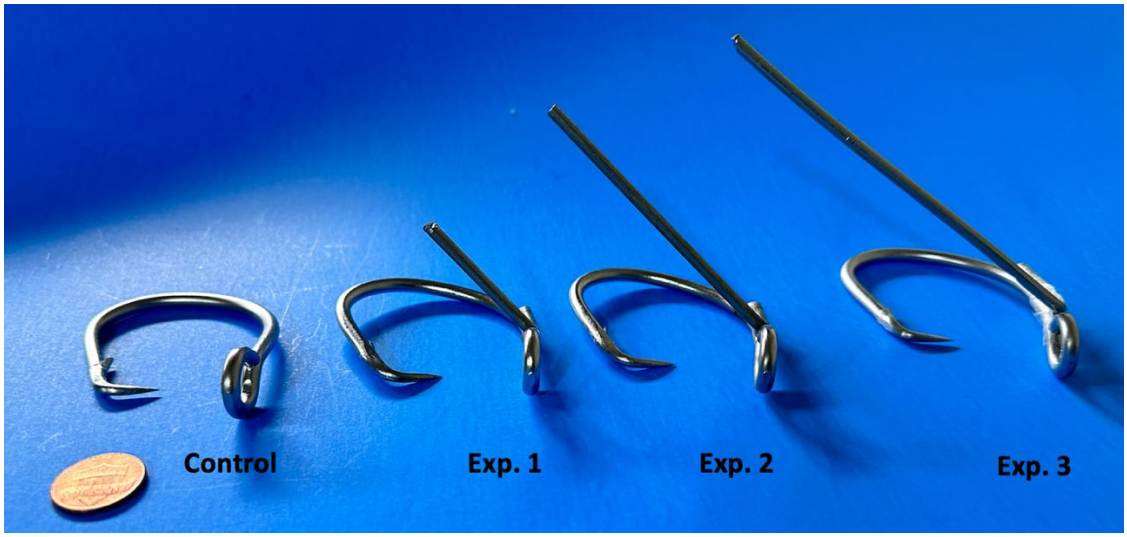


Figure 9.72. Moving left to right: Image of a control hook (no appendage present) and three experimental hooks (Exp. 1-3) with a 3.1 mm diameter wire appendage extending 3.8, 7.6, and 11.4 cm, respectively, outward from the hooks shank at a 45o angle. Scale = diameter of the United States 1 cent coin = 19 mm.

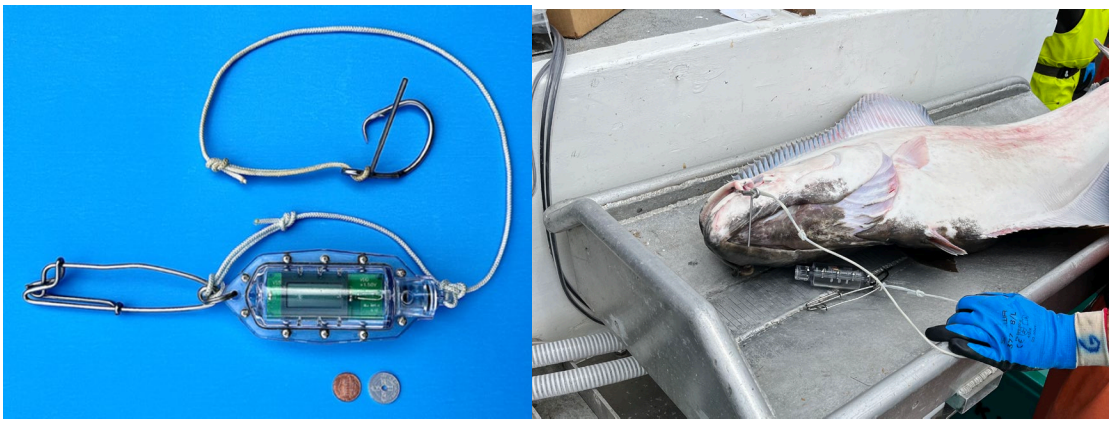


Figure 9.73. Left: Image of a hook timer rigged to a gangion with a 16/0 size hook modified with a 7.6 cm long appendage extending outward at a 45◦ angle (Scale = diameter of the Norwegian 1 krone coin displayed is 21 mm, diameter of the United States 1 cent coin displayed is 19 mm). Right: Image of a halibut caught on a gangion rigged with a hook timer.

10 Other business

10.1 Upcoming meeting dates and venue

The WGFTFB annual meeting in 2025 will be held at the Mahara Hotel Wellness in Mazara del Vallo , Sicily, Italy from 15-20 May. This meeting will be a regular ICES-FAO WGFTFB-meeting. The meeting will be hosted by the National Research Council (CNR) in Mazara del Vallo, Sicily, Italy. The logistics and on-site coordination will be led by Sergio Vitale, who heads the CNR team responsible for ensuring the smooth organization of the event. Detailed meeting information will be made available on the official WGFTFB website at wgftfb.org. The site provides updates on the agenda, logistics, and other relevant details as they become available.

In accordance with the WGFTFB workplan and Terms of Reference 2024-2026, the 2026 annual meeting of the WGFTFB will be an FAO-hosted year including an FAO led symposium with additional thematic sessions to be determined. The objective is to encourage participation by FAO developing countries and focusing content on topics of interest to those countries. The meeting will be supported by funding from the confirmed co-host, Fisheries Research and Development Corporation, on behalf of the Australian Government. The location of the 2026 meeting will be Cairns, Queensland, Australia, and is planned to take place during May 2026, dates to be confirmed at the 2025 annual meeting of the WGFTFB in Sicily. Members are encouraged to block calendars and arrange travel budgets at an early stage to ensure attendance.

10.2 Topic groups for the 2025 WGFTFB meeting

All three of the Topic Groups (TG) that met during the 2024 annual meeting (Chapters 5-7) will meet again in 2025, without an additional TG added. The TGs include:

a) Topic Group on "The use of indicators to describe and compare the performance of fishing gears" (TG Indicators). This TG was proposed during the 2021 meeting and the group first met in 2023 (see Chapter 4 for detailed information). This topic group will have its third meeting in 2025.

b) Topic Group on "Abandoned, lost, or otherwise discarded fishing gear" (TG ALDFG). This TG was also proposed during the 2021 meeting and first met in 2023 (see Chapter 6 for detailed information). This topic group will have its third meeting in 2025.

c) Topic Group on "Operational and technical constraints of fishing gears to support coexistence with offshore wind and open-ocean aquaculture" (TG Mult-use). This TG was proposed in 2023 and first met at the 2024 annual meeting (see Chapter 7 for detailed information). This topic group will have its second meeting in 2025.

10.3 Focus Sessions for the 2025 WGFTFB meeting

The concept of a Focus Session (FS) was introduced in 2024 with a focused topic of discussion and presentations convened by members of the Working Group in plenum. The intention is for these sessions to last for one year only. During the 2025 annual meeting, there will be two Focus Sessions organized. They include:

10.3.1 Focus Session 1: Collating and standardising the reporting of bottom-contacting, mobile fishing gear parameters and their fuel consumption (FS GEAR)

10.3.1.1 Conveners

Christopher Kerry (United Kingdom); Mollie Rickwood (United Kingdom); Ciaran McLaverty (United Kingdom); Kristian Metcalfe (United Kingdom); Ole Eigaard (Denmark); Sergio Vitale (Italy), Antonello Sala (Italy)

10.3.1.2 Introduction

Fishing with mobile, bottom-contacting fishing gears is the greatest way in which humans interact with marine sediments. However, a paucity of data has resulted in the reliance on widespread and untested assumptions to produce global estimates which has sparked much debate over the true footprint of bottom-fishing activity.

10.3.1.3 Terms of Reference

- Review and summarize current and past research knowledge and applications of data using vessel and gear parameters.
- Utilise the expertise and contacts of FTFB group members to develop and disseminate a survey to gather information on global vessel and gear parameter.
- Identify relevant experts that hold and maintain current and accurate data/databases on vessel and gear parameters.
- Evaluate feasibility of creating a repository of national reports that identifies the locations of publicly available reports on vessel and gear parameters.
- Create a framework for reporting of vessel and gear parameters to facilitate future work.
- To supplement the above terms of reference, additional information will be collected to establish baselines for fuel consumption by gear and area.

10.3.1.4 Justification

The accurate quantification of mobile, bottom-contacting fishing activity requires an understanding of the type and size of the gears deployed, the type and sensitivity of the seabed habitat and the frequency of interaction. The increasing uptake of vessel tracking technologies has dramatically improved our understanding of the operating behaviour and spatial distribution of vessels. However, a lack of detailed data on the variation in the type, size and characteristics of bottom-contacting, mobile fishing gears used globally restricts our ability to translate this spatial information on vessel activity into accurate footprint estimates. To circumvent this lack of data, many global estimates utilise data from studies that have focussed solely on European vessels. However, the representativeness of the European fleet at a global scale has yet to be assessed.

This topic group will focus on collating a globally representative database on mobile, bottom-contacting fishing gears. This database will hold detailed information on vessel size as well as gear dimensions and operational parameters such as depth fished. This will enable relationships between geographic location, vessel size and gear type to be established, helping to improve the accuracy of the footprint of mobile, bottom-contacting fishing activity. In addition, complementary data on fuel consumption will also be gathered to enable provide and understanding of how this varies between geographic regions and between gear types.

10.3.2 Focus Session 2: Research failures, no effects and lessons learned (FS FAILURES)

10.3.2.1 Conveners

Mattias Van Opstal (Belgium) and Jasper Van Vlasselaer (Belgium).

10.3.2.2 Introduction

Scientists typically communicate their work by emphasizing successes, positive results, and impressive data. However, behind many of these polished presentations and publications lies a less visible reality: a long journey of dead ends, frustrations, and hours of unproductive effort. Drawing from the collective experience in fisheries research, we aim to create a platform that highlights not our greatest successes, but our failures, unexpected outcomes, and the lessons learned from them.

10.3.2.3 Terms of Reference

- Share null or unexpected results.
- Share research failures.
- Provide insights and solutiions to prevent similar challenges in future research.

10.3.2.4 Justification

By openly sharing mistakes and unsuccessful experiments, scientists can prevent the repetition of ineffective approaches, ultimately saving time and resources. Regular sharing of "failure" information will lead to improved research practices across the community. Additionally, this focus session will offer a platform for collaborative problem-solving, enabling researchers to leverage group expertise to address and potentially resolve the issues that led to failed experiments.

10.4 Meeting of the working group WGSSSE in connection with the 2024 annual WGFTFB meeting

The ICES Working Group on Size and Species Selection Experiments (WGSSSE) met in-person for the first time the Sunday preceding the WGFTFB annual meeting (2 June) in St. John's given the overlap in participants between the two working groups. This WG, established in 2020, is chaired by Haraldur Arnar Einarsson (Iceland/FAO) and Michael Pol (USA). The resolution is provided below. This working group is listed here (in addition to the timing of the meetings) because it was initiated within WGFTFB with strong interlinkages in content and members. More information can be found at: https://www.ices.dk/community/groups/Pages/WGSSSE.aspx

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2024	June	St. John's, Canada	Interim report by TBD to ACOM/SCICOM	One-day meeting before or after WGFTFB
Year 2025	TBD		Interim report by TBD to ACOM/SCICOM	Election of new chairs(s)
Year 2026	TBD		Final report by TBD to ACOM/SCICOM	

ToR descriptors[3]

ToR	Description	Background	Science Plan Codes	Duration	Expected Deliverables
a	Review historical and newly developed analytical and statistical methodologies to estimate size and species selection in towed and static fishing gears, including consideration of environmental covariates (both instantaneous and modelled).	Estimates of the selectivity of commercial fishing gear are critical to fisheries management through the assessment process and the development of more selective management measures. A shared understanding of the pros and cons of different methods of estimating selectivity is vital to progress. It can be helpful to understand the process of developing new survey gear.	5.4.	1, 2 or 3 year	Continuously under scrutiny in connection to the revision of research guideline
b	Write guidelines for field data collection, including covariates which may affect size and species selection.	Knowledge of the data requirements of the different methods will result in more consistent data collection across studies, even if conducted by non-experts.	5.4.	2, 3 year	Manuscript prepared for final processing before publication.
c	Develop comprehensive guidelines for accurately estimating size and species selection for a global audience, with the best possible statistical methods and modelling known.	Wileman, et al. (1996) published a manual on the methodology for estimating retention or selectivity. WGFTFB members see a need to update the methodological information and augment it to include additional gear.	5.4.	1, 2 year	Manuscript prepared for final processing before publication.
d	Compiling the guidelines on field data collection and methods for accurately estimating fishing gear size and species selectivity into a technical report for ICES and possibly the FAO.	WGFTFB has been seeking to produce a much-needed updated manual to estimate selectivity but has struggled with time and resource issues to produce this. This WG, consisting of members of WGFTFB, aims to resolve this issue.	5.4.	1,2,3	Final technical report and guidelines

Summary of the Work Plan

Year 1	The first in-person meeting of the WG. We will review the obtained text and address pertinent issues and strategies for ongoing tasks.
Year 2	Bring text together for group editing, approval, and product near/final draft.
Year 3	Produce the final draft and determine the future of the WGSSSE.

Supporting information

Priority	The activities of this group will provide a much-needed update to a primary reference document, ICES Cooperative Research Report No. 215: Manual for Methods of Measuring the

	Selectivity of Towed Fishing Gears. The Manual is now over 25 years old and was developed before the availability of open-source statistical software and newer statistical methodology accessible due to computing power. ICES Report No. 215 is a foundational document for gear technologists.
Resource requirements	No resource requirements for ICES. Additional resources for these activities are minimal and will be drawn from members' institutions.
Participants	The Group consist of approximately 50 members, mostly drawn from WGFTFB.
Secretariat facilities	Standard support.
Financial	Publication of CRR
Linkages to ACOM and groups under ACOM	There are no obvious direct linkages.
Linkages to other committees or groups	There is a close working relationship with WGFTFB.
Linkages to other organizations	Fishing technology and operations team (NFIFO) / Food and Agriculture Organization of the United Nations (FAO)

Reference list

Szynaka, M.J., Erzini, K., Gonçalves, J.M. and Campos, A. 2021. Identifying métiers using landings profiles: an octopus-driven multi-gear coastal fleet. J. Mar. Sci. Eng. 9: 1022.

Szynaka, M.J., Fernandes, M., Anjos, M., Erzini, K., Gonçalves, J.M. and Campos, A. 2022. Fishers, Let Us Talk: Validating Métiers in a Multi-Gear Coastal Fishing Fleet. Fishes. *7*: 174.

Annex 1: List of participants

List of participants 2024

The meeting was conducted in person. Audio/video of the plenary sessions was streamed through Facebook Live for online participants. The following table lists the participants who registered and attended the meeting in person, listed by country alphabetically.

ID	Name	Institution	Country	Email
1	Silvana Dans	RedCID	Argentina	vanadans@gmail.com
2	Steve Eayrs	FRDC	Australia	steve.eayrs@frdc.com.au
3	Jasper Van Vlasselaer	ILVO	Belgium	vanvlasselaer.jasper@gmail.com
4	Lancelot Blondeel	ILVO	Belgium	lancelot.blondeel@ilvo.vlaanderen.be
5	Mattias Van Opstal	ILVO	Belgium	mattias.vanopstal@ilvo.vlaanderen.be
6	Brad Henderson	Notus	Canada	brad@notus.ca
7	Brian Sullivan	DFFA-GovNL	Canada	briansullivan@gov.nl.ca
8	Colin Frank	Marine Institute	Canada	colin.frank@mi.mun.ca
9	Darrell O'Brien	DFFA-GovNL	Canada	darrellobrien@gov.nl.ca
10	Derek Curtis	DFFA-GovNL	Canada	derekcurtis@gov.nl.ca
11	Elizabeth Vezina	CWF	Canada	elizabethb@cwf-fcf.org
12	Francis Parrot	Notus	Canada	francis@notus.ca
13	Genevieve Peck	Marine Institute	Canada	genevieve.peck@mi.mun.ca
14	George Legge	Marine Institute	Canada	george.legge@mi.mun.ca
15	Jill Conway	Marine Institute	Canada	jill.conway@mi.mun.ca
16	Kelly Moret	Hampidjan Canada	Canada	kmoret@hampidjan.ca
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Annex 2: Resolutions

The ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB), chaired by Noëlle Yochum (U.S.A.), Antonello Sala (Italy), and Jon Lansley (on behalf of FAO), will meet to work on the following Terms of References (ToRs) and produce deliverables as listed in the following table for the years 2024 through 2026. WGFTFB will report on the activities and findings within three months of meetings to EOSG.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2024	3-7 June	St. Johns, Canada	Final report by September 30, 2024 to EOSG	Outgoing chair: Daniel Stepputtis Incoming chair: Noëlle Yochum Renew FAO chair: Jon Lansley
Year 2025	15-20 May	Mazara del Vallo, Italy	Final report by September 30, 2024 to EOSG	Outgoing chair: Antonello Sala. Incoming chair: Paul Winger
Year 2026	TBD	Queensland, Australia	Final report within three months of the meeting to EOSG	FAO-sponsored meeting, with additional thematic sessions. Election of new chair(s)

ToR descriptors

ToR	Description	Background	Science Plan Codes	Duration	Expected Deliverables
a	During annual meetings, deliberate, discuss and synthesize recent research on topics related to: i) designing, planning, and testing of fishing gears used in abundance estimation; ii) selective fishing gears for the reduction of bycatch, discard and unaccounted mortality; iii) environmentally benign fishing gears, including innovations to mitigate ALDFG and the risk of 'ghost fishing' and methods; iv) improving fuel efficiency and reduction of emission from fisheries; v) fish behaviour near and inside fishing gear as it relates to the previous topics; vi) summaries of relevant research activities by nation; and vii) innovative technologies improving the safety of fishing operations.	Through open sessions and focused, multi-year topic groups, the Working Group provides opportunities for collaboratively developing research proposals, producing reports and manuscripts, and creating technical manuals on current developments and innovations.	3.3, 4.5, 5.4	Years 1 and 2	ICES report
b	Organize an FAO-ICES symposium as described in (a) with additional thematic sessions to be determined in year 2.	Under mutual agreement between ICES and FAO, FAO develops and leads a symposium of relevant topics, while also continuing ICES commitments.	2.1, 4.5, 5.4	Year 3	ICES- FAO joint report , published by FAO
c	Support FAO members, and ICES working groups and workshops with fishing gear and fish behaviour expertise upon request.	EOSG has identified gear expertise gaps in other working groups (e.g., survey) and workshops.	3.2	Years 1-3	Report of relevant working groups or associated workshops

Summary of the Work Plan

Year 1	Organize an annual meeting; produce a meeting report; provide expertise to FAO and other ICES WGs and workshops upon request
Year 2	Organize an annual meeting; produce a meeting report; provide expertise to FAO and other ICES WGs and workshops upon request
Year 3	Organize an FAO-ICES symposium; produce meeting reports (ICES and FAO); provide expertise to FAO and other ICES WGs and workshops upon request

Supporting information

Priority	The activities of WGFTFB will provide ICES and FAO members with knowledge, expertise, and guidance on issues related to the ecosystem effects of fisheries, especially the evaluation and reduction of the impact of fishing on marine resources and ecosystems and the sustainable use of living marine resources and other topics related to the performance of commercial fishing gears and survey gears and their safe operation.
Resource requirements	The research programmes that provide the main input to this working group already exist, and resources are already committed by individual institutions. FAO has committed to supporting the WG by sponsoring a WG symposium every third year. There are no additional resource requirements for the EG beyond the secretariat support for group organization.
Participants	The group is normally attended by about 60–100 regular members and chair-invited members. Participation is approximately 100-150 in the year when FAO-ICES symposium is held. The numbers of attendees to the meeting have been growing in recent years.
Secretariat facilities	None
Financial	A new group website (wgftfb.org) was developed during the 2020-2023 term. Funds for hosting maintenance going forward may be covered by Memorial University of Newfoundland and website management is provided by Antonello Sala. Apart from these costs, there are no additional resource requirements for the WGFTFB beyond the secretariat support for group organisation. There are no financial commitments required for membership or participation in the annual meetings.
Linkages to ACOM and groups under ACOM	Linkages to advisory groups as required.
Linkages to other committees or groups	There is a very close working relationship with other groups of EOSG, e.g. WGSSE, WGFAST, DSTSG, and HAPISG.
Linkages to other organizations	The WG is jointly sponsored by the FAO.

Annex 3: Agenda of the meeting (including side events)

Time / Days	Sunday June 2	Monday June 3	Tuesday June 4	Wednesday June 5	Thursday June 6	Friday June 7
08:00-08:15		Bus Departs from the Alt Hotel Daily at 08:00				
08:15-08:30						
08:30-08:45		Registration & Assemble in Plenary Room (Hang posters)	Assemble in Plenary	Assemble in Plenary	Assemble in Plenary	Assemble in Plenary
08:45-08:55						
8:55-09:00			Daily Updates	Daily Updates	Daily Updates	Daily Updates
09:00-09:15		Welcome, Opening Remarks, Etc.	Moderator: Elsa Cuende	Topic Group Introductions	Moderator: Steve Eayrs	Business Meeting and Updates
			Selectivity: Morfin (9)	Moderator: Kelsey Richardson	Human Behaviour: Pol (26)	
09:15-09:30			Selectivity: Cerbule (10)	ALDFG: Matsushita (20)	Human Behaviour: Catchpole (27)	
09:30-09:45			Selectivity: Browne (11)	ALDFG: Ssempijja (21)	Human Behaviour: Stott (28)	
09:45-10:00			Selectivity: Veiga- Malta (12)	Multi-Use: Pol (22)	Human Behaviour: Eayrs (29)	
10:00-10:15			Selectivity: Araya-Schmidt (13)	Multi-Use: Tray (23)	Human Behaviour: Whitman (30)	
10:15-10:30			Selectivity: Brinkhoff (14)	Indicators: Melli (24)	Human Behaviour: Schram (31)	
10:30-10:45			Selectivity: Bayse (15)	Indicators: Blondeel (25)	Fish Behaviour: Karlsen (32)	
10:45-11:00		Coffee Break (hang posters)	Coffee Break	Coffee Break	Coffee Break	Coffee Break (remove posters)
11:00-11:15						
11:15-11:30		Moderator: Yoshiki Matsushita	Moderator: Tomas Araya-Schmidt	Topic Group Meeting	Moderator: Junita Karlsen	Ibero-American Network (38)
		Benthic Interactions: Rickwood (1)	Selectivity: Bak-Jensen (16)		Fish Behaviour: Berzosa (33)	Moderator: Drake Ssempijja
11:30-11:45		Benthic Interactions: O'Neill (2)	Selectivity: Cuende (17)		Fish Behaviour: Gauld (34)	Innovative Gear: Vlasselaer (39)
11:45-12:00		Benthic Interactions: Huda (3)	Discard Survival: Molenaar (18)		Fish Behaviour: Frank (35)	Innovative Gear: Rillahan (40)
12:00-12:15		Benthic Interactions: Takahashi (4)	Discard Survival: Oliver (19)		Innovative Gear: Sala (36)	Innovative Gear: Santos (41)
12:15-12:30		Lunch & Flume Tank Demonstration	Building Tour, Lunch & Field Trip		Innovative Gear: Moran (37)	Innovative Gear: Andrade (42)
12:30-12:45				Lunch & Flume Tank Demonstration	Lunch & Flume Tank Demonstration	Lunch
12:45-13:00						
13:00-13:15						
13:15-13:30						
13:30-13:45		Moderator: Barry O'Neill		Topic Group Meeting	Focus Session Introduction	Moderator: Drake Ssempijja
		Energy Use: Oliver (5)				Innovative Gear: Nguyen (43)
13:45-14:00		Energy Use: Van Opstal (6)			Focus Session (Includes 50-65)	Innovative Gear: Ljungberg (44)
14:00-14:15		Energy Use: McHugh (7)				Innovative Gear: Noack (45)
14:15-14:30		Energy Use: Krag (8)				Innovative Gear: Frandsen (46)
14:30-14:45		Group Photo/ Student Photo				Coffee Break
14:45-15:00						Moderator: Noëlle Yochum
15:00-15:15		Poster Session				Innovative Gear- Whales: Dykstra (47)
15:15-15:30				Coffee Break	Coffee Break	Innovative Gear- Whales: Vaczin (48)
15:30-15:45						Innovative Gear- Whales: Skripsky (49)
15:45-16:00				Topic Group Meeting	Focus Session (Includes 50-65)	Meeting Wrap Up
16:00-16:15						
16:15-16:30						
16:30-16:45						
16:45-17:00						
17:00-17:15						
17:15-17:30						
17:30-17:45						
17:45-18:00					Focus Session Final Discussion	
18:00-21:00	Welcome Reception			Banquet		

Annex 4: Details of plenary presentations and posters

Topic Name	ID	Title	Email
Benthic Interactions	1	Enhancing our understanding of global variability in industrial fisheries footprints; a synthesis of mobile, bottom-contacting fishing gears	c.kerry@exeter.ac.uk
Benthic Interactions	2	Sediment penetration by bottom contacting fishing gear components	barone@aqua.dtu.dk
Benthic Interactions	3	The snagging of towed demersal fishing gears on boulders	nuhu@aqua.dtu.dk
Benthic Interactions	4	Impact of the mooring systems on seabed	chiyo42takahashi@gmail.com
Energy Use	5	Assessment of artificial light on the headline towards improving energy efficiency in the Celtic Sea trawl fishery for demersal fish species	martin.oliver@bim.ie
Energy Use	6	Development of an innovative and light-weight chain mat for the Belgian beam trawl fishing fleet	mattias.vanopstal@ilvo.vlaanderen.be
Energy Use	7	Using pair seining to reduce fuel in a demersal fishery	matthew.mchugh@bim.ie
Energy Use	8	Two birds with one stone: simultaneous improvements of fuel efficiency and catch performance in demersal trawling	Lak@aqua.dtu.dk
Selectivity	9	INSER R Package: INdicators of SElectivity in Routine	sonia.mehault@ifremer.fr
Selectivity	10	Selectivity in snow crab (Chionoecetes opilio) pot fishery: effect of escape gap shape and size for conservation of fishery resources	kristine.cerbule@uit.no
Selectivity	11	King scallop selectivity in the English Channel dredge fishery	daragh.browne@bim.ie
Selectivity	12	Are we wasting tax-payers money? Questioning the use of sea trials to test simple codend modifications.	timat@aqua.dtu.dk
Selectivity	13	Novel escape window reduces redfish bycatch in Northern shrimp trawls	tomas.schmidt@mi.mun.ca
Selectivity	14	Make fisheries better by reducing size selectivity	Ilmar.brinkhof@uit.no
Selectivity	15	Uppers and downers: picking a sustainable gear for a new redfish fishery	shannon.bayse@mi.mun.ca
Selectivity	16	Understanding and predicting codend size selection for flatfish species	zitba@aqua.dtu.dk

Topic Name	ID	Title	Email
Selectivity	17	Evaluating bottom trawl fishery in the Bay of Biscay from the fish community perspective	ecuende@azti.es
Discard Survival	18	Discard survival and fish quality improvements by using a Modular Harvest System (MHS) in demersal beam trawl fisheries	pieke.molenaar@wur.nl
Discard Survival	19	Survivability of spurdog (Squalus acanthias) caught in the Irish demersal trawl fishery	martin.oliver@bim.ie
ALDFG	20	Effects of ALDFG on sessile organisms and eelgrass bed	yoshiki@nagasaki-u.ac.jp
ALDFG	21	Global inland fisheries: Plastic pollution and other conservation challenges	dssempijja@umassd.edu
Multi-Use	22	Staying in your lane: Scaled images of mobile fishing gears in U.S. offshore wind arrays	mike@rosascience.org
Multi-Use	23	A global assessment of fishing within offshore windfarms to inform recommendations for Ireland marine spatial planning process	Elizabeth.Tray@bim.ie
Indicators	24	Fisheries ecolabels and FIshing Gears Indicators (FIGI): overlap, synergies and future directions	vmel@aqua.dtu.dk
Indicators	25	An indicator based, voluntary assessment scheme enabling transition towards a more sustainable fishery	lancelot.blondeel@ilvo.vlaanderen.be
Human Behaviour	26	Advancing the uptake of proven fishing gear: an update	mike@rosascience.org
Human Behaviour	27	Investigating the barriers and challenges for UK fishers in taking up more selective fishing gears to avoid unwanted catches	thomas.catchpole@cefas.gov.uk
Human Behaviour	28	Road test selected trawl designs in the English northeast Nephrops (N. norvegicus) fishery	samantha.stott@cefas.gov.uk
Human Behaviour	29	Moving forward: Australia national extension officer network facilitating change in the fishing and aquaculture industry	steve.eayrs@frdc.com.au
Human Behaviour	30	Increasing uptake of the Ultra Low Opening Trawl (ULOT) in the New England Groundfish Fishery	awhitman@gmri.org

Topic Name	ID	Title	Email
Human Behaviour	31	Economic viability of new passive fishing methods for brown shrimp (Crangon crangon) in the Dutch Wadden Sea: a business-economic approach	edward.schram@wur.nl
BeFish Update/ Fish Behaviour	32	Time for action: A plea for establishing quo vadimus on the future relevance of animal behavior in the development of sustainable fisheries	jka@aqua.dtu.dk
Fish Behaviour	33	Optimizing Fish Pot Design for Targeting Flatfish: A Two-Phase Approach to Enhance Efficiency	sara.berzosa@thuenen.de
Fish Behaviour	34	Bridging missing links in fish attraction to lights through field and laboratory studies	dgauld@umassd.edu
Fish Behaviour	35	Snow Crab Vision Fishing Gear, Phosphorescence, and the Environment	colin.frank@mi.mun.ca
Innovative Gear	36	Innovative fishing gears	antonello.sala@cnr.it
Innovative Gear	37	Selectivity design for the Modular Harvesting System, a non-mesh codend	damian.moran@plantandfood.co.nz
		The behaviour of fish in the Modular Harvesting System, a non-mesh codend	damian.moran@plantandfood.co.nz
Business Session	38	Ibero-American Network for the Study of Bycatch and Discards	mhall665@gmail.com
Innovative Gear	39	Fisheries in transition: Researching innovative bait and novel potfishing opportunities	jasper.vanvlasselaer@ilvo.vlaanderen.be
Innovative Gear	40	Survey dredges do not sample well in high-density scallop grounds: New evidence from high-definition cameras	crillahan@umassd.edu
Innovative Gear	41	KingGrid: An innovative design paradigm for rethinking sorting grids	juan.santos@thuenen.de
Innovative Gear	42	Developing techniques to reduce Greenland shark bycatch in Northern shrimp trawls	sidney.andrade@mi.mun.ca
Innovative Gear	43	Effective techniques to develop a sustainable redfish fishery in Canada	vang.nguyen@mi.mun.ca
Innovative Gear	44	Test fishing meeting mechanistically understanding â€“ a case study of gear development targeting the invasive round goby (Neogobius melanostomus)	peter.ljungberg@slu.se
Innovative Gear	45	Screw, Snap, Fish: First experiences with a modular and more resilient Pontoon Trap design	thomas.noack@thuenen.de
Innovative Gear	46	Embracing new and more efficient fishing gears with focus on their impact on the catch composition	rif@aqua.dtu.dk

Topic Name	ID	Title	Email
Innovative Gear- Whales	47	Protecting fish captured on longline gear from removal by whale depredation.	claude.dykstra@iphc.int
Innovative Gear- Whales	48	Co-existence of species at risk and fisheries through the trial and adoption of on-demand gear	elizabethb@cwf-fcf.org
Innovative Gear- Whales	49	A framework for evaluating on-demand fishing gear suitability for Atlantic Canadian commercial fixed-gear fisheries	sahras@cwf-fcf.org
FOCUS SESSION	50	Improving discard quantification on commercial fishing vessels. Discard valves, load cells and catch estimations	allard.vanmens@wur.nl
	51	Reducing fishing impacts in marine ecosystems: modifications to set nets	mjszynaka@gmail.com
	52	An Intelligent Discard Chute with Optical Imaging and Machine Learning to Revolutionize the Electronic Monitoring Program for New England Groundfish Fishery	phe@umassd.edu
	53	Panoramic Perspectives and Extended Battery life: Advancing Underwater Observation in Fisheries technology	thomas.noack@thuenen.de
	54	AI Catch - A pioneering concept with ultrasonic sonar sensors and a mechanical valve to optimize catches in beam trawl fisheries	mattias.vanopstal@ilvo.vlaanderen.be
	55	VISTools. Fishing vessels as automatic data-gathering platforms a win-win for fishers and scientists	lancelot.blondeel@ilvo.vlaanderen.be
	56	Automatic 3D fish tracking to assess fish behavior inside trawls	robin.faillettaz@ifremer.fr
	57	Sampling techniques and AI for Fishing Technology and Fish Behaviour Introducing SNTech CatchCam and SeaSensor products	tom@sntech.co.uk
	58	smartFishing â€“stereo-camera system for trawl observation	daniel.stepputtis@thuenen.de
	59	Commercially available technologies for monitoring fisheries efficiencies and impacts	tom@sntech.co.uk
	60	Active Selection Progress: Improving ActSel systems and facilitating their application to reduce bycatch	fishnextresearch@gmail.com
	61	Open sesame: design of a moving escape gate and species-specific reactions to an active selection device in the aft of a trawl	melanie.underwood@niwa.co.nz
	62	Technology-based precision fishing with real-time decision making in demersal trawl fisheries	Lak@aqua.dtu.dk
	63	Abandoned, lost or otherwise discarded fishing gear (ALDFG)â€“ Introducing MyGearTag Acoustic lost gear technology	tom@sntech.co.uk

Topic Name	ID	Title	Email
	64	Spatial and temporal distribution of fish near wind turbines using underwater video cameras	khankowsky@umassd.edu
	65	Smart Buoy Technology for Gear Marking and Data Collection	kortney.opshaug@blueoceangear.com
POSTERS	A	Result of the fishing gear marking experience in Argentina	rroth@inidep.edu.ar
	B	Spreading a bottom trawl without doors: a proof of concept using flexible foils	Paul.Winger@mi.mun.ca
	C	Galvanizing crab traps: prolonging lifespan while maintaining snow crab catch	peter.brown@mi.mun.ca
	D	Should I stay or should I go?	peter.ljungberg@slu.se
	E	Approaching single-species exclusion in mixed demersal trawl fisheries	vmel@aqua.dtu.dk
	F	CanFISH Gear Lending Program: a solution to whale closures in Atlantic Canada	kirklenj@cwf-fcf.org
	G	Behavioral ecology informs fishing gear design : The case study of Black seabream baited structure	marianne.robert@ifremer.fr
	H	Enhancing sustainability in snow crab fisheries: collaborative solutions for improving size selectivity, catch efficiency, and mitigating ghost fishing	kristine.cerbule@uit.no
	I	Entanglement in fishing gear is one of the primary threats inhibiting the recovery of critically endangered North Atlantic right whales (NARWs)	genevieve.peck@mi.mun.ca
	J	Enhancing Fisheries Data Collection Through Electronic Monitoring and AI Technology	sander.delacauw@ilvo.vlaanderen.be
	K	Can pots be an alternative fishing gear to gillnets? A Mediterranean case study	andrea.petetta@cnr.it
	L	Enhancing Durability and Efficiency of Purse Seine: A Study on variation in gear component strength and innovative design concept	dhijudas@gmail.com
	M	Measuring weak breaking strength gear modifications before and after use in Atlantic Canadian fixed-gear fisheries	Krysu@cwf-fcf.org
	N	Decarbonisation of the fishing fleet in the Mediterranean and Black Sea (DecarbonyT)	antonello.sala@cnr.it
	O	Underwater observation plays a crucial role in fisheries technology, where the introduction of low-cost action cameras has significantly enhanced this aspect	thomas.noack@thuenen.de
	P	Failures, no effects and lessons learned: An overview of unwanted results	jasper.vanvlasselaer@ilvo.vlaanderen.be
	Q	Fish and click: how participatory science help to describe the distribution of lost fishing gear	dorothee.kopp@ifremer.fr

Annex 5: Opening Adress by FAO chair Jon Lansley

Opening Address by: Mr Jon Lansley Fishery Industry Officer, Food and Agriculture Organization of the United Nations (FAO)

Colleagues, Ladies and Gentlemen,

It is a great pleasure and honour to welcome you on behalf of FAO's Fisheries and Aquaculture Division, to the 2023 meeting of the ICES-FAO Working Group on Fishing Technology and Fish Behaviour and Symposium on Innovations in Fishing Technologies for Sustainable and Resilient Fisheries.

I would like to begin by expressing my sincere gratitude to the Government of India. In particular the Bay of Bengal Inter-Governmental Organisation (BOBP-IGO), for generously hosting this Working Group meeting and symposium. The interest of India to work with ICES and FAO is very much appreciated, and I am sure all Working Group members share my pleasure to be, not only participating in the first psychical meeting in 3 years, but to be achieving this here in Kochi, Kerala.

The Working Group was given a global mandate in 2002 when FAO accepted the invitation of the ICES to form a joint Working Group. In 2011, ICES and FAO further discussed the purpose and methods of collaboration. It was agreed that FAO would co-chair the annual meeting and host the meeting every third year at a location chosen by FAO. Previous locations chosen by FAO were, Thailand in 2013, Mexico in 2016, and China in 2019.

For FAO, the main objective of this collaboration is to involve more developing countries in the work of this group;

- to promote exchange of information between experts working around the globe on fishing technology innovations, and
- to facilitate technology transfer and uptake of responsible and sustainable fishing technologies and practices, by fishing fleets worldwide.

It is the first time that a WGFTFB meeting has been held in South Asia. It is hoped this will result in increased memberships and ongoing participation from the region. I stress this is a two-way collaboration. The Working Group will benefit just as much from the experience brought in by new regional experts, as new members will benefit from the collaboration with the Working Group. In the short time I have been in Kochi I have been very impressed by the warm welcome and wealth of expertise that National Institutes such as the Central Institute of Fisheries Technology (CIFT), the Central Marine Fisheries Research Institute (CMRF), and the School of Industrial Fisheries have demonstrated.

It hasn't been possible to hold a physical meeting during the last 3 years for reasons associated to COVID-19 travel restrictions, and then the war in Europe. For many reasons this has been a

very difficult time, for far too many people. However, during this period advances in fishing technology and related fields has still been achieved, owing to the dedication, and adaptable nature of fishing gear technologists and researchers worldwide, and through the course of this week we will learn about many examples of this.

From the FAO, contributions over the last two years include:

ongoing support for the implementation of the FAO Voluntary Guidelines on the Marking of Fishing Gear;

ongoing efforts to address negative environmental impacts caused by abandoned, lost or otherwise discarded fishing gear (ALDFG) and other forms of marine pollution caused by fishing operations; and

ongoing efforts to prevent and reduce unwanted bycatch.

Details on FAO activities will be provided through the course of this meeting, through a series of presentations from myself and other FAO colleagues.

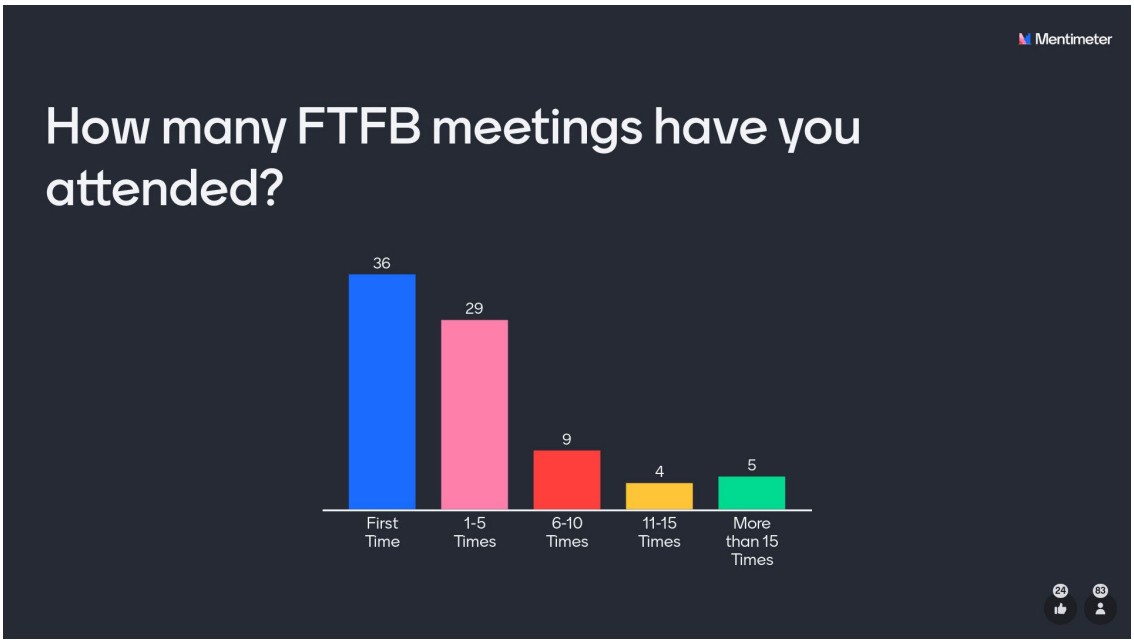
On behalf of FAO, I would like to express my gratitude especially to Dr P. Krishnan and his team at the the Bay of Bengal Inter-Governmental Organisation (BOBP-IGO), for the organisation of this event. Also to the chair-persons of this ICES-FAO Working group. Dr Antonello Sala and Dr Daniel Stepputtis for the excellent work throughout the past year in preparation of this important event.

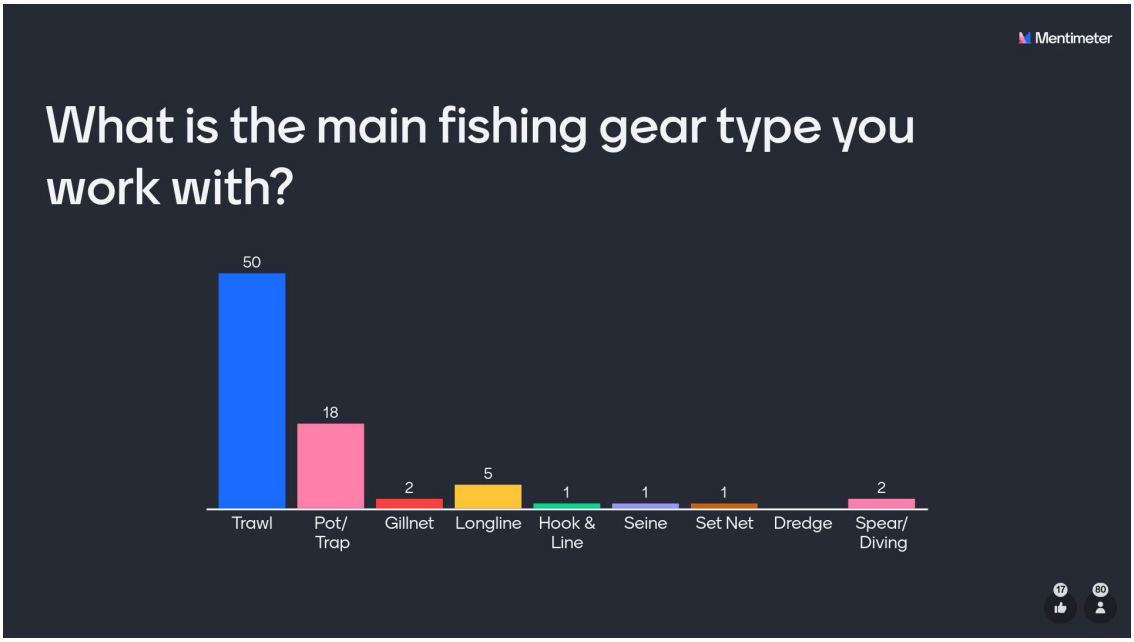
Please rest assured that the FAO will do all we can to assist progress of this Working Group. Not just over the next few days, but also into the future.

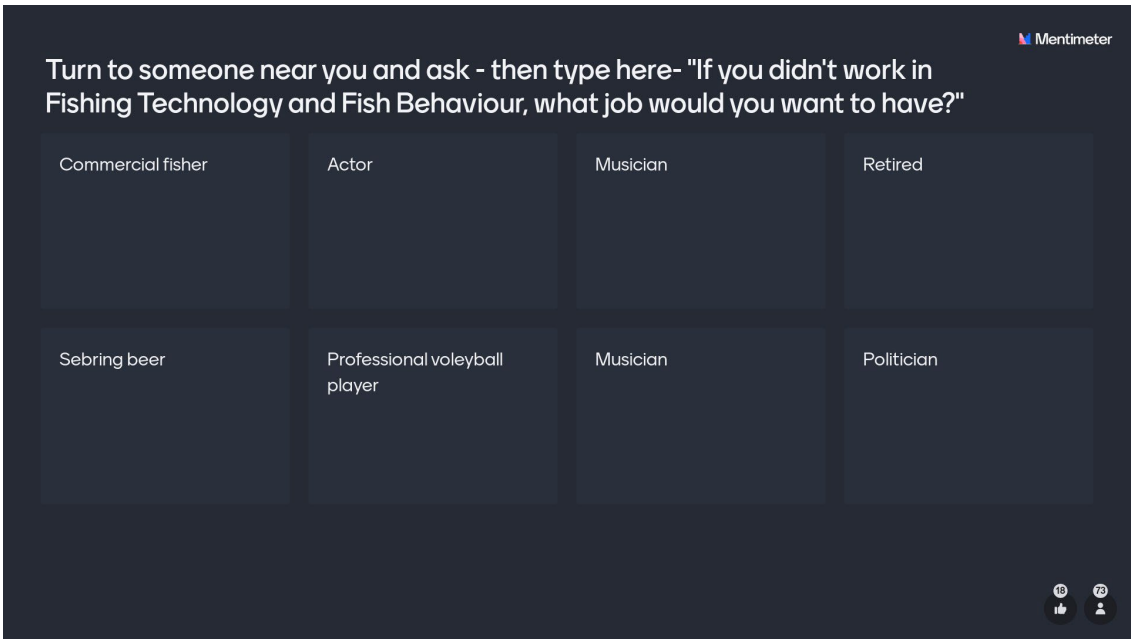
I wish you a productive Symposium and Working Group meeting.

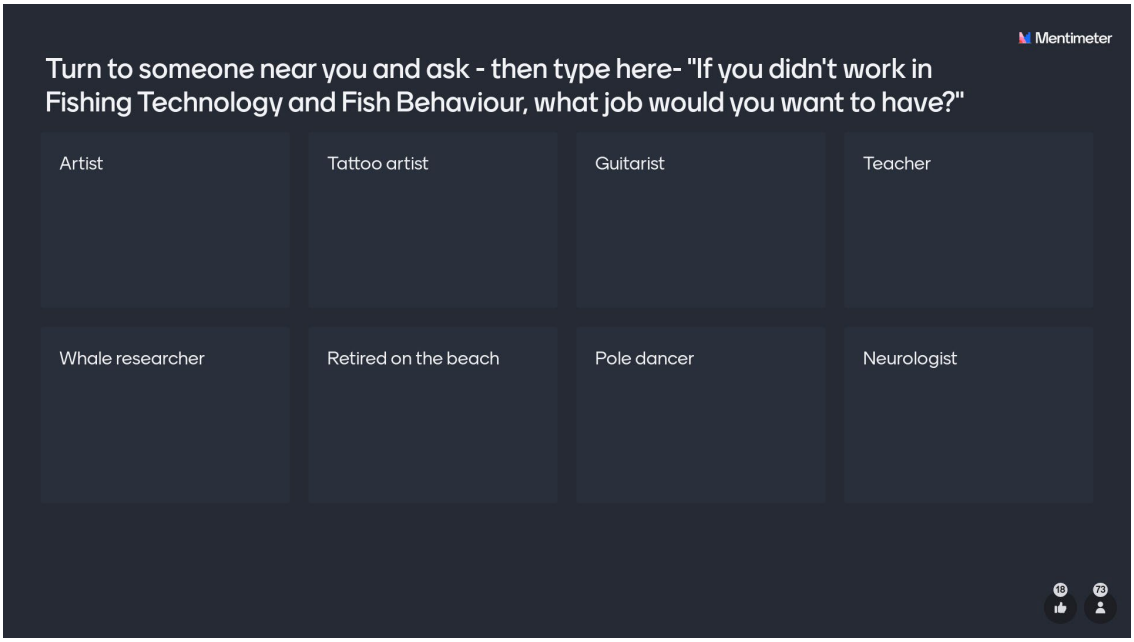
Annex 6: Results from Opening Questionnaire

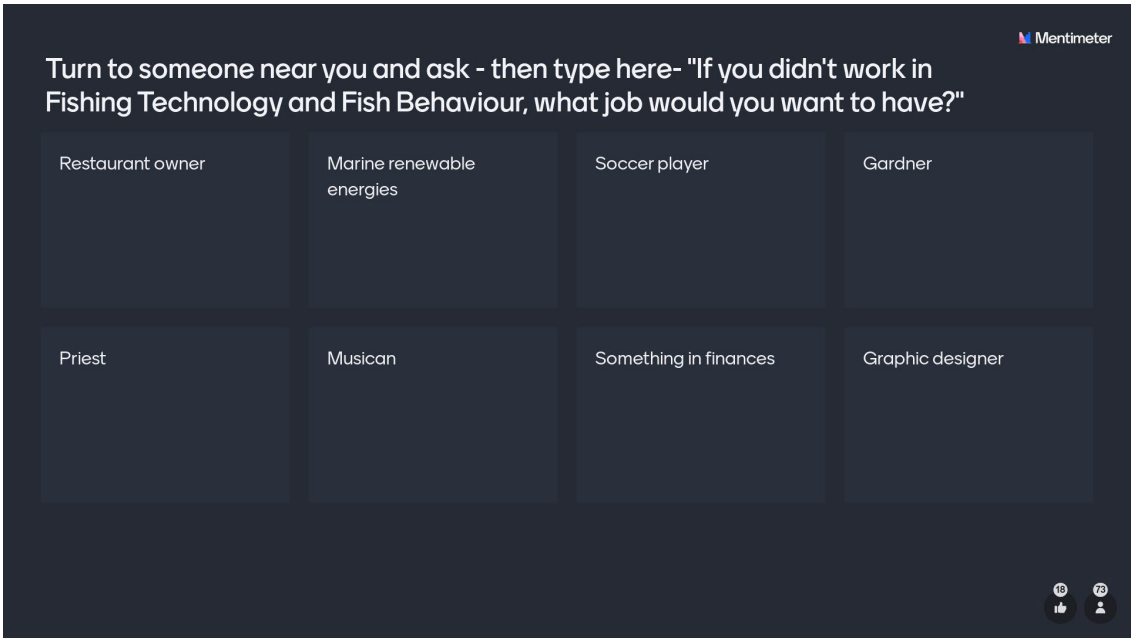
During the opening session of the meeting, an interactive questionnaire was given by the chairs to the meeting participants (via www.mentimeter.com). The results of the questionnaire are given here.

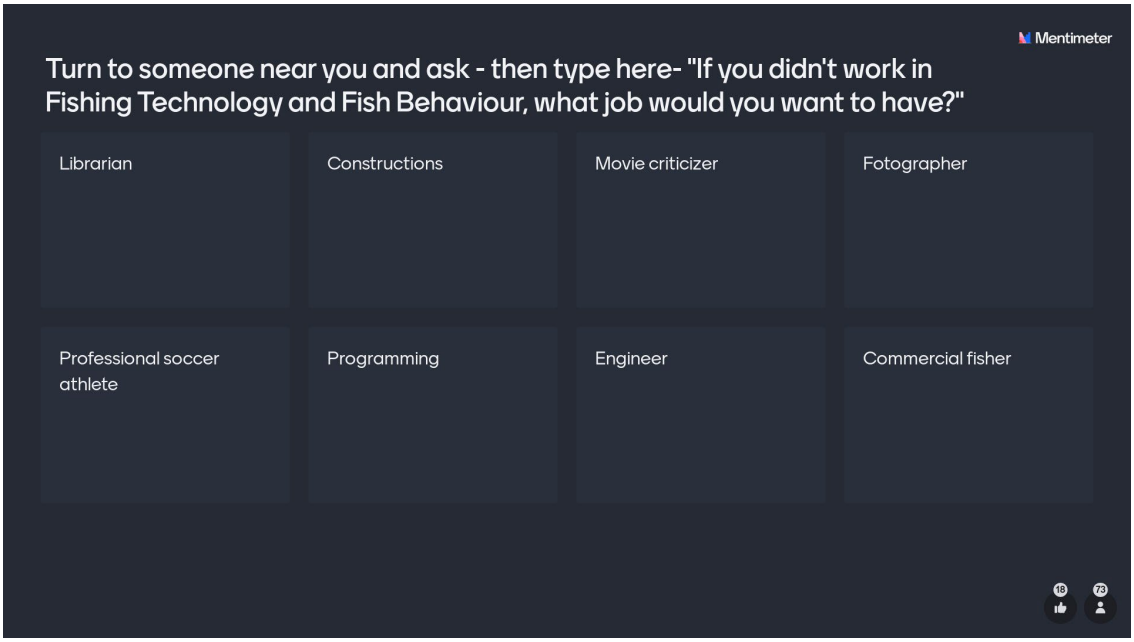


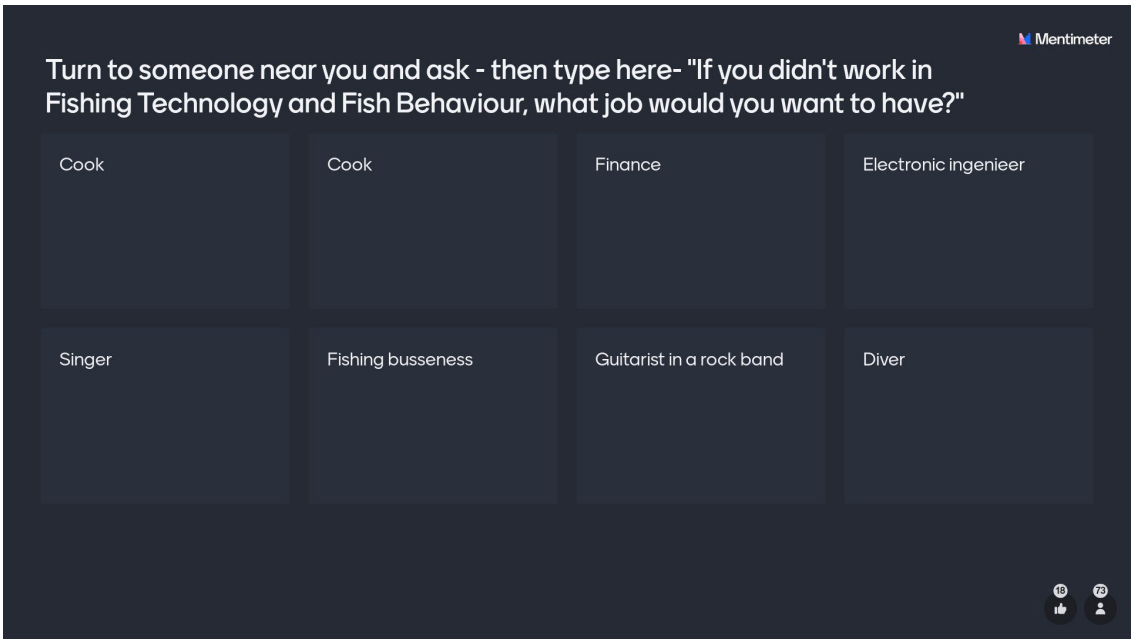

Mentimeter
What is the main fishing gear type you work with?
50
18
2
5
1
1
1
2
Trawl
Pot/ Trap
Gillnet
Longline
Hook & Line
Seine
Set Net
Dredge
Spear/ Diving
17
80

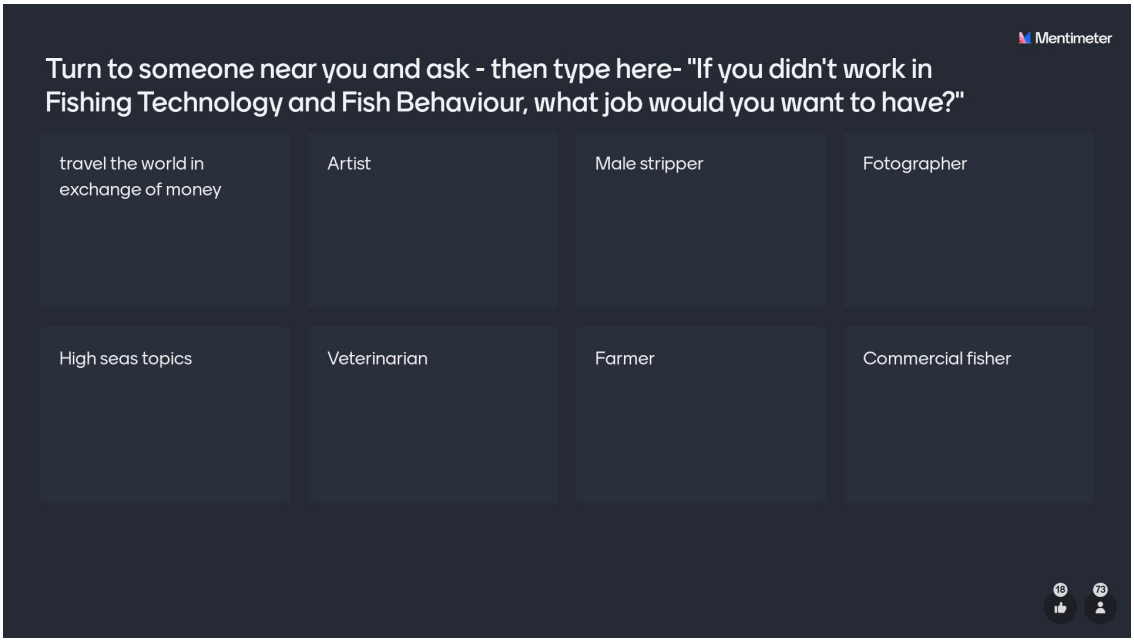

Mentimeter
Turn to someone near you and ask - then type here- "If you didn't work in Fishing Technology and Fish Behaviour, what job would you want to have?"
Commercial fisher
Actor
Musician
Retired
Sebring beer
Professional voleyball player
Musician
Politician
18
73

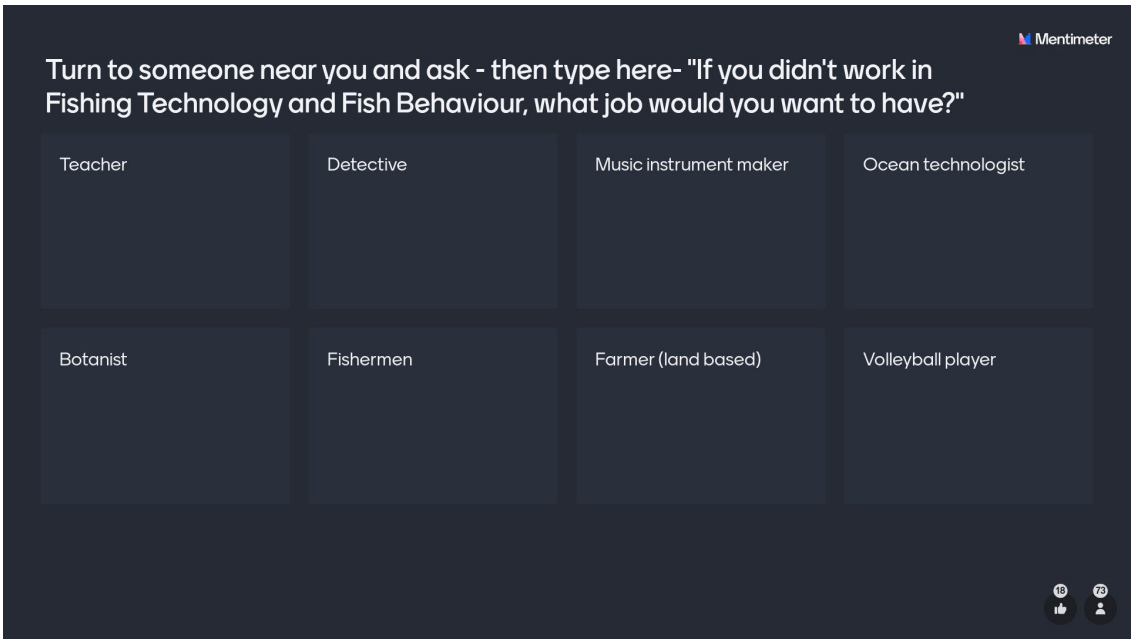

Mentimeter
Turn to someone near you and ask - then type here- "If you didn't work in Fishing Technology and Fish Behaviour, what job would you want to have?"
Artist
Tattoo artist
Guitarist
Teacher
Whale researcher
Retired on the beach
Pole dancer
Neurologist
18
72

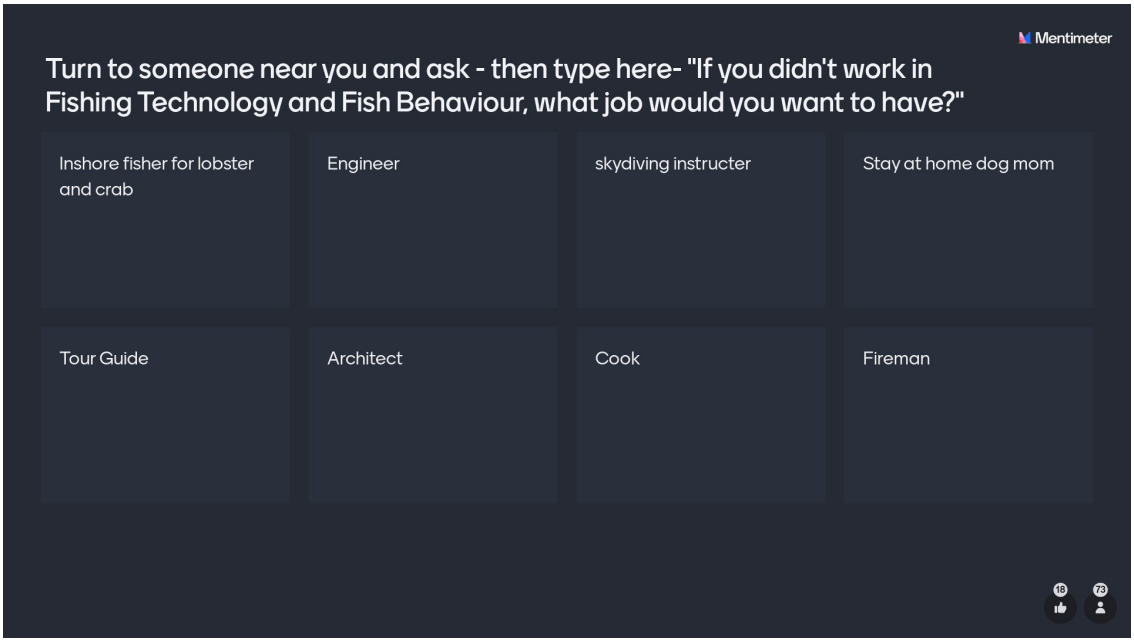

Mentimeter
Turn to someone near you and ask - then type here- "If you didn't work in Fishing Technology and Fish Behaviour, what job would you want to have?"
Restaurant owner
Marine renewable energies
Soccer player
Gardner
Priest
Musican
Something in finances
Graphic designer
18
73

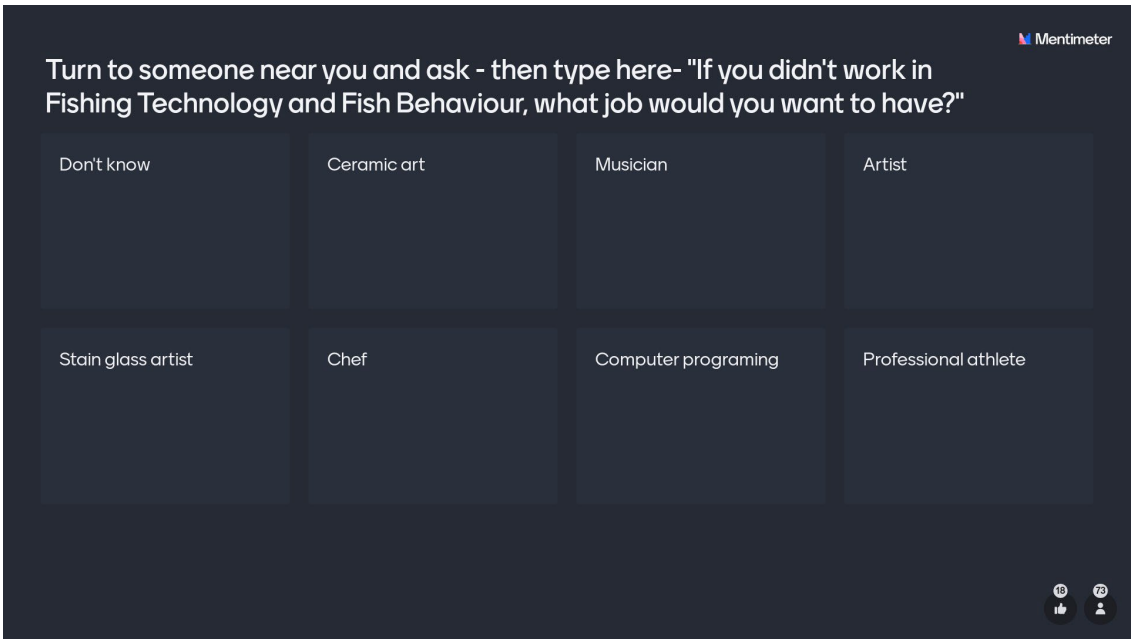

Mentimeter
Turn to someone near you and ask - then type here- "If you didn't work in Fishing Technology and Fish Behaviour, what job would you want to have?"
Librarian
Constructions
Movie criticizer
Fotographer
Professional soccer athlete
Programming
Engineer
Commercial fisher
18
72


Mentimeter
Turn to someone near you and ask - then type here- "If you didn't work in Fishing Technology and Fish Behaviour, what job would you want to have?"
Cook
Cook
Finance
Electronic ingenieer
Singer
Fishing busseness
Guitarist in a rock band
Diver
18
73


Mentimeter
Turn to someone near you and ask - then type here- "If you didn't work in Fishing Technology and Fish Behaviour, what job would you want to have?"
travel the world in exchange of money
Artist
Male stripper
Fotographer
High seas topics
Veterinarian
Farmer
Commercial fisher
18
72


Mentimeter
Turn to someone near you and ask - then type here- "If you didn't work in Fishing Technology and Fish Behaviour, what job would you want to have?"
Teacher
Detective
Music instrument maker
Ocean technologist
Botanist
Fishermen
Farmer (land based)
Volleyball player
18
73


Mentimeter
Turn to someone near you and ask - then type here- "If you didn't work in Fishing Technology and Fish Behaviour, what job would you want to have?"
Inshore fisher for lobster and crab
Engineer
skydiving instructer
Stay at home dog mom
Tour Guide
Architect
Cook
Fireman
18
72


Mentimeter
Turn to someone near you and ask - then type here- "If you didn't work in Fishing Technology and Fish Behaviour, what job would you want to have?"
Don't know
Ceramic art
Musician
Artist
Stain glass artist
Chef
Computer programing
Professional athlete
18
72

Mentimeter

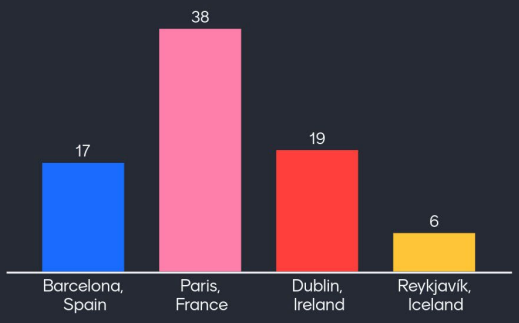
Turn to someone near you and ask - then type here- "If you didn't work in Fishing Technology and Fish Behaviour, what job would you want to have?"

Fish harvester

18 72

Mentimeter

What European city is at the latitude closest to St. John's?

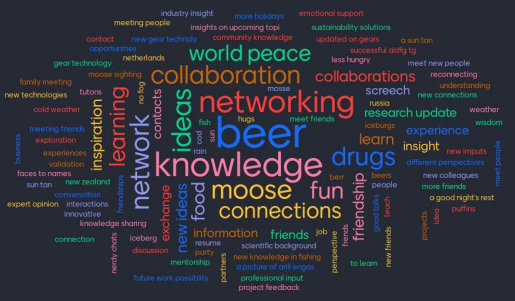


16 80

Mentimeter

What are you hoping to get out of this meeting?

354 responses



Mentimeter

What country would you like to see host an FTFB meeting soon?

136 responses